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LION'S HEAD TAKEN BY INSTANTANEOUS PHOTOGRAPHY.

WE have often remarked how valuable, from the standpoint of art as well as of science, are those new gelatino-bromide photographic processes that allow negatives to be taken instantaneously. Henceforward, as we have before said, we shall have, by means of instantaneous photography, that motion, life, and expression that have hitherto been wanting. We have already shown what has been done by Mr. Muybridge, of San Francisco, and Mr. Marey, of the Institute, and we have also given several specimens of a less important order, but nevertheless remarkable, of different instantaneous photograps of living animals of the Museum of Paris, etc. We offer now to naturalists a new and remarkable example, this being the portrait of the head of a lion confined in the Zoological Gardens at London. The proof, which was sent to us from England, was photographed directly upon the wood by the aid of a peculiar collodion which is now being very much used. Our engraver, Mr. Tilly, has consequently executed the accompanying engraving by doing the cutting on the photograph itself, so that the latter, not having passed into the hands of a draughtsman, has in no wise been modified or changed in nature.—*La Nature.*

THE SNAKE BIRD.

THE mechanism of the neck in the darters (*Plotus*) is treated by W. A. Forbes in the Proceedings of the London Zoological Society. The darters feed entirely, so far as Mr. Forbes had been able to observe, under water. "Swimming with its wings half expanded, though locomotion is effected entirely by the feet, the bird pursues his prey (small fishes) with a peculiar darting or jerking action of the head and neck, which may be compared to that of a man poising a spear or harpoon before throwing it. Arrived within striking distance, the darter suddenly transfixes, in fact, bayonets, the fish on the tip of its beak with marvelous dexterity, and then immediately comes to the surface, where the fish is shaken off the beak by jerking of the head and neck (repeated until successful), thrown upward, and swallowed, usually head first." A study of the neck in the recently dead bird leaves little doubt as to the mechanism by which this peculiar impaling of the prey is effected. The eighth cervical vertebra is articulated with the seventh in such a way that the two cannot naturally be got to lie in the same line, but form an angle, open forward, of about 145°, when the two bones are stretched as far as possible in that direction. After further describing the mechanism, Mr. Forbes thus concludes his paper: "It is obvious that considerable advantage is gained by the action in question, the rapid protrusion of the narrow neck and head over a small space by this mechanism necessitating a less amount of exertion than would a similar movement of the whole bird over the same space, and being equally efficacious in striking the prey. The whole mechanism, it may be observed, exists in a less developed form in the neck of the herons, cormorants, etc.; and it requires but a slight modification of the arrangement of these parts in those birds—none of which, so far as I know, impale their prey like the darters—to bring about the perfect adaptation of these structures to a newly acquired mode of feeding.

Mr. Forbes' observations refer to the Indian darter (*Plotus melanogaster*), but will undoubtedly apply to our Anhinga bird.

LION'S HEAD TAKEN BY INSTANTANEOUS PHOTOGRAPHY.

RAILROAD CARS AS A MEANS OF DISSEMINATING MOTHS.

HAVE you ever thought of the railroads as a means of disseminating Noctuidæ? Traveling more than usual the past fall and summer, I was often struck with the numbers of Aletiæ on the trains. There were probably many others on the outside fluttering at the lights or at rest upon the cars. I do not give it as of great value or by any means conclusive; but there has been this season a sort of coincidence between lines of railroad and abundance of cotton worms. The northern limit of these last, so far as I could learn, in central Mississippi was just south of Holly Springs, in Marshall County, within a breadth of some fifteen miles, five east of the railroad and eight or ten west thereof. On the Mobile and Ohio road, in the eastern part of the State, the northern limit of the worms was Baldwyn, with a western spread of eighteen or twenty miles. Between Baldwyn and Booneville, the next station to the north, is an almost desert stretch of twelve miles of low, swampy land, nearly destitute of cotton, and but one night train runs northward. On the Mississippi Central, on the contrary, there were some three regular north-bound trains at night.

Another coincidence is worthy of mention. In 1881 I could hear of Aletiæ, north of Tallahatchie, only at two points, both in this (Marshall) county. The first extended from the river northward four miles, and but a short distance east and west of the railroad. The second was four miles south of Holly Springs, on the eastern side of the track. In 1880 there were two points of propagation of Aletia north of Tallahatchie; one near Waterford, the first station, four miles north, and the other at Holly Springs, fourteen miles north of the river. The latter was in the nearest cotton to the station, and nearly a mile east of it, the town lying to the west. —*Judge Lawrence Johnson, Holly Springs, Miss., in Amer. Naturalist.*

POISON OF SCORPIONS.

M. JOYEUX-LAFFUIE finds that the poison organ of the scorpion (*S. occitanus*) is formed by the last abdominal segment, where two small oval orifices serve for the exit of the poison; there are two glands, equal in size, and symmetrically arranged; each occupies a space, covered externally by the chitinous skeleton, and having internally an interior and posterior membrane, formed by striated muscular fibers, which are inserted into the chitinous skeleton. By their contraction the poison is forced outward. The wall of the gland consists of a delicate layer, formed by cellular tissues and smooth muscular fibers; on its internal surface there are projecting lamellæ, which increase the extent of the secreting surface; below this is a layer of prismatic cells, which are filled with protoplasm, containing in suspension, and in abundance, fine rounded granulations, which are characteristic of the poison of the scorpion, and hide the nuclei, which only become apparent on the addition of acetic acid; these are the cells which elaborate the poison, and from which it escapes, by the rupture of the cells, into the central cavity of the organ.

Physiologically, this poison is very active, and that in direct relation to the quantity introduced; one drop is soon fatal to a rabbit and still more active on a bird; seven to eight frogs may be killed by one drop, and the hundredth part of one is fatal to an ant of large size. It would appear to affect the nervous system, and has undoubtedly a marked action on striated muscle, suppressing spontaneous and reflex movement. —*Journal of the Royal Microscopical Society.*

REPUGNATORIAL PORES IN THE LYSIOPETALIDÆ.

HAVING received specimens of *Lysiopetalum carinatum*, Brandt, from Dalmatia, which is a very large species, I have been able to examine the repugnatorial pores, which are very distinct, their crateriform openings being situated each between two ridges on the anterior edge of the raised portion of the scute. The two European species mentioned are provided with setæ, while our *L. lactarium* is naked. In the latter series the repugnatorial pores are situated in the middle of the yellow lateral spot, between two carinæ, which are higher and closer together than any of the others. They can be seen with a Tolles triplet.

Re-examining the cave Lysiopetalid, *Pseudotremia cavernarum*, Cope, from Wyandotte cave, and a variety (*carterensis*) which inhabits the Carter caves, Ky., I cannot with certainty discover their site, as they are nearly, if not quite, obsolete. It is possible that in cave species, where there are apparently no enemies of these myriapods, their spores become at least externally obsolete.—*A. S. Packard, Jr., in Amer. Naturalist*

THE HOME OF THE PAILLE-EN-QUEUE, OR TROPIC BIRD.

ELEVATED in the air, far above the masts, is seen at sea in warm latitudes the tropic bird (*Phaeton*), its two long projecting tail-feathers looking like a single slender shaft from its white body, while on suspended wing, turning its head to and fro, it examines the vessel below. Sailors call it the "boatswain," perhaps from its whistling note, or because it carries a "marline spike." The *Phaeton ætherius* has the tail feathers white, but the *phœnicurus* is much handsomer, the tail being like scarlet wires. This species, which lays one egg, breeds at Round Island, near Mauritius, where it is called the Straw-in-Tail, or Paille en-Queue. Our drawing is by Lieutenant-Colonel H. Robley, Sutherland and Argyll Highlanders, who with a party landed on this island, with the usual difficulty, for except on a very fine day, and at only one particular rock, demanding an arobatic feat to attempt from a boat, can this be done. There is no water on the steep sandy slopes, and any rain that falls is at once

THE HOME OF THE PAILLE-EN-QUEUE (PHAETON ÆTHERIUS), OR BOATSWAIN BIRD, ROUND ISLAND, NEAR MAURITIUS.

soaked up. The scant vegetation is very curious, as, there being little earth, all the stunted trees have shallow roots, or grow on stilts, such as the "bottle" and other palms. The crannies and ledges of the sand-rocks are alive with the innumerable nests, where the breeding birds are seen, their whereabouts marked by the tell-tale red indicating feathers, fifteen inches long. These birds permit no others on the island, the white species at Mauritius and Bourbon keeping quite separate. Their feathers are valuable. The young Paille-en-Queue, which looks like a white puff-powder ball, is without any at first, till in time it becomes a swift ranger of the ocean. While all around were engaged in fishing, these tropic birds were in immense numbers. The party got about 2,000 feathers without injury to the birds, which would not leave their nests, guarding their callow brood, but suffered themselves to be plucked when pecking at a proffered stick or butt of gun.—*London Graphic.*

MALACOSTEUS NIGER, AYRES.

By Prof. W. O. AYRES, M.D.

IN the SCIENTIFIC AMERICAN of March 17 appeared an account of a very singular fish, *Eurypharynx pelecanoides*,

MALACOSTEUS NIGER, AYRES.

copied from *La Nature*, the original notice of which by M. Vaillant had been published in *Comptes Rendus* of Dec. 11, 1882. The alliance of *Eurypharynx* with the genus *Malacosteus*, as originally described by me, was strongly insisted upon, and the publication of Vaillant's description in your columns, accompanied by an excellent figure, seemed to render a comparison of the two species quite desirable.

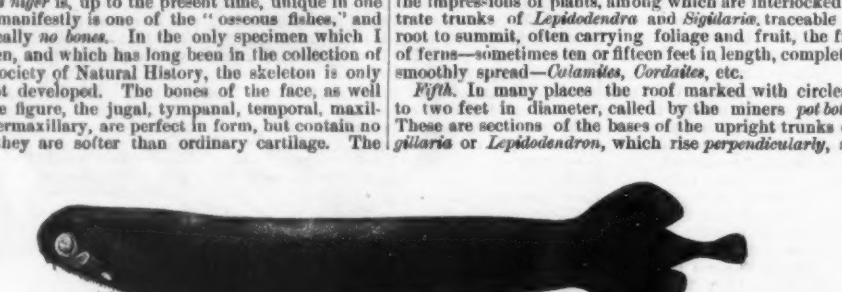
My description of *Malacosteus niger* was published in Dec., 1848, and from that date till the present discovery the genus has stood alone. It differs so widely from all other ichthyic types that even its place in the system, counting no closer than by families, has not been well settled, though it has seemed probable that my own suggestion of its proximity to *Scopelus* would be eventually adopted. Nothing, however, in the thirty years and more has come to light which could be deemed in any way even analogous to the genus, until last year, in the deep water off the coast of Morocco, this wonderful *Eurypharynx* was dredged up by the Travailleur from a depth of 1,300 fathoms. This no longer leaves *Malacosteus* to stand by itself, for although M. Vaillant suggests that his species may need to be ranged under my former generic name, leaving it to stand as *Malacosteus pelecanoides* this does not seem to me admissible. The two genera are quite distinct, and each will retain its own rank.

The feature which links them together, and which at the same time separates them so widely from all other fishes, is the small size of the head as compared with the enormous development of the jaws. A glance at the figures shows this without a detailed description. Whether in *Malacosteus* there may have been in life a pouched appendage to the lower jaw, such as that possessed by *Eurypharynx*, is uncertain, though it is by no means impossible. The figure represents the fish accurately as it came into my possession, but it had then been many weeks preserved in alcohol, and it is readily seen that the tissues and membranes connected with the lower jaw had been injured, while in every other respect the specimen was perfect. The tongue is shown standing out by itself, and a loop passing from it to the symphysis of the jaw, which evidently is not a natural feature. A pouch somewhat like that of *Eurypharynx* is at least suggested.

With this astonishing arrangement of the jaw apparatus the close alliance of the two genera seems to cease. In other respects they vary so widely that they must ever be held distinct. In *Eurypharynx* the dorsal and anal fins are long, low, occupying the greater part of the entire length; in *Malacosteus* they are short, rounded, recalling in form and position entirely those of our common pickerel. The pectorals have no similarity, while in *Eurypharynx* the ventrals are stated to be wanting. The branchial orifices are remarkably dissimilar: in *Eurypharynx* it is "a simple rounded cutaneous perforation;" in *Malacosteus* it is extremely large and free, opening to an extent of an inch and eight-tenths in a fish eight and a half inches long. The teeth in *Malacosteus niger* are, as shown, a feature of great prominence; in *Eurypharynx pelecanoides* they are scarcely manifest.

These points are too many, and appear of too great importance, to allow a co-generic classification. Both names, *Malacosteus* and *Eurypharynx*, must be retained, and though allied to *Stomiatidæ*, yet their alliance with *Scopelidæ* seems closer.

Malacosteus niger is, up to the present time, unique in one respect. It manifestly is one of the "osseous fishes," and yet it has really *no bones*. In the only specimen which I have ever seen, and which has long been in the collection of the Boston Society of Natural History, the skeleton is only indicated, not developed. The bones of the face, as well shown in the figure, the jugal, tympanal, temporal, maxillary, and intermaxillary, are perfect in form, but contain no bone-cells; they are softer than ordinary cartilage. The



MALACOSTEUS NIGER, AYRES.

name *Malacosteus* (soft-boned) is derived from this fact, and is good unless future specimens shall show that the original one of 1848 was abnormal.

Eurypharynx and *Malacosteus* are probably alike in one thing: they are deep water fishes. The former was dredged as already stated; of the latter my specimen was found floating to the eastward of the Grand Bank. It was almost lifeless, and had probably come up from below, and was perishing in its change of condition. I am informed that among the recent results of deep water explorations by the United States Fish Commission specimens of *Malacosteus niger* have been secured, and we may thus presently know more of its structure and history.

ON THE PHYSICAL CONDITIONS UNDER WHICH COAL WAS FORMED.

By Prof. J. S. NEWBERRY.

THE mode of formation of coal has been much discussed, and various theories have been promulgated in regard to it; but the peat bog theory, as it is called, has been generally accepted. This is the view that coal is the residual hydrocarbon of plants which have grown where their remains are found, and that it has been formed precisely as peat accumulates in marshes at the present day.

So great has been the harmony of opinion on this subject, that it would at first sight appear unnecessary to renew discussion on a question that has seemed to be definitely and permanently settled. The calm of geological opinion which has prevailed on the coal question has, however, been recently disturbed by a very voluminous and painstaking discussion of the mode of the formation of coal by M. Grand Eury, which occupies nearly three hundred pages in the "Annales des Mines" for the year 1882. In this discussion the theory is advocated that the carbonaceous matter forming beds of coal has been derived from plants, but plants transported from their places of growth and deposited at a greater or less distance in the bottom of water basins.

We have reports also, from time to time, of a system of experiments and observations made by M. Fayol, at Commentry, in the Departement d'Allier, in Central France, from which he draws the same inference, and it is apparent that a formidable attack has been made, all along the line, upon the peat bog theory.

For this reason, and in order that geological truth shall be maintained, I venture to report some facts that I have myself observed in the coal fields of the Mississippi Valley, and which, in my judgment, are incompatible with the conclusions of MM. Grand Eury and Fayol.

The opinions presented in the discussion of the chemical and physical history of coal have been based upon two classes of facts, viz.: (1) those gathered from the study *in the field* of the structure and relations of the coal beds; and (2) those obtained from chemical and physical experiments conducted *in the laboratory*. Now, while there is no doubt that such experiments have contributed much to our understanding of the subject, it is obvious that they have misled observers, through the impossibility of imitating by artificial means the grand processes of Nature. She has, in many instances, left a full and faithful record of her work, but the same difficulties attend the disinterment and translation of this buried record that have been encountered by the students of archæology in their efforts to trace the early history of mankind. Necessarily this is a work of time, and much study is required for the acquisition of a full and accurate knowledge of the language in which it is written, and for the gradual accumulation of the large number of facts required. Yet I claim that so much of Nature's record of the processes pursued in the formation of coal has been submitted to our observation, and this record is so clear, that the truth is within our reach; and further, that this truth is discordant with the results obtained in artificial experimentation, and therefore proves such results fallacious.

In the present communication nothing like a full discussion of the arguments *pro* and *con* will be attempted, since the time at my command will permit me to cite only a few of many facts, and to very briefly read their meaning.

For the present, I will confine myself to some of the phenomena presented by one of the Ohio coal beds, with which I am specially familiar. This is our "Coal No. 1," the lowest of the series, sometimes called the Brier Hill coal. As this seam has furnished a fuel of exceptional purity, such as could be used in the raw state for the smelting of iron, and lies nearer to the navigable waters of Lake Erie than any other, it has been very extensively worked. The result of this working has been to show that the coal is confined to a small part of the area it was once supposed to cover, and that it lies in a series of narrow troughs or basins, which were evidently once peat marshes, occupying local depressions in the then existing surface. A large number of these detached coal deposits have been now completely worked out, and the phenomena they present fully exposed to view. Among these phenomena I may cite:

First. Below the coal a fire-clay, penetrated in every direction with roots and rootlets of *Lepidodendron*, *Sigillaria*, etc.

Second. A coal-seam having a maximum thickness of six feet in the bottom of the basins, thinning out to feather-edges on the sides, and containing only two to three per cent of ash.

Third. The coal on the margins of a basin rising sometimes thirty or forty feet above its place on the bottom.

Fourth. A roof composed of argillaceous shale, of which the lower layers, a few inches in thickness, are crowded with the impressions of plants, among which are interlocked prostrate trunks of *Lepidodendra* and *Sigillariæ*, traceable from root to summit, often carrying foliage and fruit, the fronds of ferns—sometimes ten or fifteen feet in length, complete and smoothly spread—*Calamites*, *Cordaites*, etc.

Fifth. In many places the roof marked with circles one to two feet in diameter, called by the miners *pot bottoms*. These are sections of the bases of the upright trunks of *Sigillaria* or *Lepidodendron*, which rise *perpendicularly*, sometimes many feet, into the overlying shales. They consist of hollow cylinders of coal, perhaps a half an inch in thickness, the interiors of which are filled in with shale laminated horizontally, and sometimes containing remains of plants and animals which must have been introduced when they were hollow stumps standing where they grew.

Sixth. In certain circumscribed areas part of the coal seam is cannel, bituminous shale, or black band iron ore; and in all cases of this kind the cannel, shale, and black band contain the remains of aquatic animals, crustacea, fishes, or mollusks; the normal or cubical coal never including any thing of the kind.

Seventh. The boundaries and bottoms of the channels and

basins which hold the coal are composed of the Waverly shales, or the Carboniferous conglomerate.

Eighth. The normal or cubical coal laminated by alternate layers of a bright, black, pitchy substance, and those which are dead black, non-caking, and composed largely of mineral charcoal; the cannel and black band containing more earthy matter, and not laminated.

From these facts I translate the following history, which I am sure will be accepted as true by every geologist who has had sufficient experience in field work to make his judgment of such phenomena trustworthy.

I. At the beginning of the formation of the Coal measures, Northeastern Ohio was a land surface underlain by the Waverly shales, or beds of gravel, now the Conglomerate. This surface was furrowed by the valleys of streams and pitted by local basins similar to those which mark the present surface.

II. With a slow subsidence, which continued with interruptions throughout the Coal measure epoch, the drainage was checked and lakes and marshes were formed in the depressions of the surface. In these basins a fine sediment was deposited—the "fire clay"—like the clay now found under some of our peat beds. When overgrown with vegetation the roots of plants, penetrating this silt, drew out of it iron, potash, soda, etc., leaving it nearly pure silicate of alumina and specially refractory, whence its use and name.

III. The marshes and lakes were ultimately filled with peat, which rose to a general level, near the water-line, and was sometimes thirty or forty feet deep in the deepest parts of the basins.

IV. In places water basins remained such through a considerable portion of the time occupied in the accumulation of the peat, and sluggish streams flowed through the marshes, connecting these basins, and transporting to them fine mechanical sediment, iron, etc., which, mingling with completely macerated vegetable tissue, formed cannel coal, black band iron ore, and bituminous shale. After a time these basins also were filled with peat growing from the margins, just as our lakelets are now filled and converted into peat marshes.

V. After ages had passed with the physical conditions described, a subsidence caused a submergence of the peat marshes, which first resulted in the destruction of the generation of growing plants which covered them. These dropped in succession leaves, twigs, and branches, and finally most of the tree-trunks also fell. Some, however, continued longer to maintain an upright position, while the fine argillaceous sediment suspended in the water was slowly deposited to form the roof shale, of which the lower layers are charged with the debris of the plants growing on the marsh, the upper layers, deposited when these were all buried, nearly barren of fossils.

VI. The weight of the superincumbent mass pressed down the bed of peat, which, consolidated by that process and undergoing internal chemical changes, ultimately became a bed of coal, thickest in the deepest part of each basin, thinning and rising on each side up to its edge, which remained to mark the original level of the surface of the peat marsh.

VII. The laminated structure of the normal coal is apparently due to seasonal or secular variations in the conditions under which it was formed; variations likely to occur in a marsh accumulation, hardly possible in a lake deposit. Wet seasons, by producing more surface water and more complete preservation of the softer tissues of the marsh vegetation, would promote the formation of the pitchy layers, richer in hydrogen. Dry seasons or cycles may be credited with the formation of the sheets of woody tissue and mineral charcoal, the result of partial oxidation through longer exposure to the air.

The homogeneity and more abundant ash of the cannel and black band are the natural consequences of their deposition as carbonaceous mud at the bottom of water which carried some earthy matter of foreign origin.

The presence of the remains of fishes, crustacea, and mollusks in cannel and black band is sufficient evidence of their aquatic origin; their complete absence from the cubical coal is an equally good argument in favor of its sub-aerial origin.

I have elsewhere discussed the mode of formation of cannel coal, and as the facts there cited have a bearing on the question now raised, I would refer the reader for a fuller presentation of these facts to the *American Journal of Science*, second series, vol. xxiii., 1857, p. 212; and to the *Geological Survey of Ohio*, vol. ii., *Geology*, p. 125.—*School of Mines Quarterly.*

THE PITCH LAKE OF TRINIDAD.

By JOHN FOWLER, U. S. Consul, Island of Trinidad.

I VISITED the so-called Pitch Lake, Trinidad, September 30, 1883, landing per steamer at La Brea, on the west coast of Trinidad, about 40 miles south of the port of Port-of-Spain. The lake in question is situated about 1½ miles from the shore. There is a gentle ascent of 140 feet from the shore to the lake.

The name "lake" is a misnomer, if we understand by the term a cavity containing a liquid. The contents of this cavity, or supposed cavity, is a concrete, slightly flexible mass of pitch; it is a level plain, on which bushes, and patches of vegetable formations, and pools of water are seen here and there over the surface. There is no difficulty in walking or wading over it from end to end, or from side to side. The shape of this plain is a sort of ellipse or ovoid. The water in the pools is rain water, having a slight iron taste.

Arriving on the plateau, I found, first, a number of chestnut colored females washing and bleaching linen, and in other parts a number of two wheeled carts, drawn each by a single horse, in the act of being loaded with pitch. Scattered here and there over the surface were to be seen dark, yellow-brown colored men with pickaxes digging out large clods of pitch, which boys gathered out from the pit and piled up for the carters. The pitch at almost every blow of the pickax broke off with a resinous fracture quite easily.

Each lump of pitch exhibited air cavities of the size of a pigeon's egg, larger or smaller. I was informed by the diggers that they never dig deep enough to find the pitch soft and plastic; but they asserted that in the course of a couple of days the cavity which they had dug would be again level with the surrounding plain. This assertion, I think, must be taken with considerable reservation, for I do not believe there is now any force below that would cause the pitch to rise, and I discovered no *fumerolles* anywhere that would indicate an internal fire. Besides, wherever there is a water pool there is an indication that pitch has been dug out. There is, however, a probability that the rough surface of a pit may be softened by the heat of the sun during the dry season, and thus partially leveled.

This pitch deposit, I imagine, like any other mineral deposit, will become entirely exhausted in the course of time, resembling in this respect our oil wells in Pennsylvania. But it will take a long time to do this, for the area of this visible deposit is about 100 acres, which is equivalent to 4,360,000 feet, and 4,360,000 feet surface and 1 foot deep will give the same number of cubic feet. Now, allowing the weight of 1 cubic foot of pitch to be 60 pounds (it is really more), we shall get by computation 261,360,000 pounds, which number divided by 2,240 gives 116,678 tons for the weight of a single layer of pitch on Pitch Lake 1 foot deep.

We will now suppose that 60,000 tons of pitch (this year 30,000 will be near the real amount) are dug out annually; we shall find that this first layer of pitch will supply the world for two thousand years.

How deep this pitch deposit is absolutely is not yet known with accuracy, or even approximately. The whole ground, under a thin layer of soil or sand, to the ocean is pitch, and there is (I have been informed and have myself partially seen) an outcropping of pitch on the beach of the Gulf of Paria at different points for 5 or 6 miles north and south of La Brea. This deposit of bitumen or asphalt is, therefore, from all appearances inexhaustible for thousands of years to come.

This deposit of asphalt belongs to the colonial government of Trinidad, and the right of *exploitation* of the entire Pitch Lake, with the exception of five acres reserved for government purposes alone, is leased out to three parties, namely, Conrad F. Stoelmeyer (represented by his son Charles F. Stoelmeyer, and who is at the same time business manager for the company), T. A. Finlayem & Co. (representative of the London Asphalt Company), and Thomas Field (representing the American or New York Asphalt Company).

To the United States asphalt is shipped in a crude state, like clods of clay. In this form I would recommend it to be always imported to America, because it does not agglutinate in the transit, and may be even carried on the deck; secondly, because the price of the crude asphalt is much cheaper than that of the so-called *epure* asphalt; and thirdly, because our means of boiling asphalt are altogether superior to the method at La Brea.

For the European market the pitch is made liquid by heat, in which state it is ladled out into flour barrels, and allowed to concrete by cooling. One hundred such barrels filled with pitch weigh about sixteen tons, or 320 lb. per barrel.

The crude pitch is transferred from the shore to the ships in boats estimated to contain five tons each.

This pitch is delivered on vessels on the coast for exportation at $3.25 per ton, all charges included.

THE GREAT COMET OF 1882 AS SEEN IN INDIA.

WE have hitherto published a large number of documents from the most remote regions of the globe, in reference to the great comet of 1882, but the one that we offer to-day is certainly one of the most curious that we have received. It consists of a letter and a splendid photograph that have been sent to us from Pondicherry, under date of January 23, 1883. The letter is as follows:

THE GREAT COMET AS SEEN AT PONDICHERRY, INDIA.

"I have the honor to send you a photograph of the great comet, taken on the quay at Pondicherry, on the 27th of September, at three minutes before five o'clock in the morning. There may be remarked in it very well the brilliancy of the nucleus, the convexity of the tail (which is directed toward the south), the shadowy line that divides the tail throughout its length, and, finally, the slender, rectilinear line that seems to continue the convex part of the tail. This latter remarkable peculiarity has not yet, I believe, been referred to in the articles that have appeared in *La Nature.*

"Nothing can give you an idea of the truly striking spectacle that was offered us by this magnificent star as it rose every morning; and it was not without a genuine emotion that the immense incandescent fascicle was seen issuing from the horizon and rising in the heavens, while a column of fire seemed to glide over the surface of the sea and threaten the observers who were stationed along the shore.

"We were favored with superb weather, and, for a number of days, were enabled every morning to contemplate this splendid meteor at our ease. The photograph was taken by a native named Francine. J. PHILAIRE."

Our collaborator, Mr. Richard Cortambert, has, on another hand, communicated to us the following observations made at Congo:

"One of my correspondents, Mr. Louis Petit, who is stationed at Landana, very near the mouth of the Congo, has described to me the apparition of the magnificent comet from the beginning of November. By the western Africans it was observed, after three o'clock in the morning, in an easterly direction. The nucleus could not be distinguished very well, but it appears that its immense tail was seen admirably. It was very luminous, and much longer and infinitely more beautiful than the comet that the same traveler saw in France in 1881."—*La Nature.*

THE SWEET GUM TREE.

By Prof. LAWRENCE C. JOHNSON, Holly Springs, Miss.

IN the systematic works of Botany: Liquidamber—STYRACIFLUA—Order: HAMAMELACEÆ.

To those who are unfamiliar with the mysteries of scientific classification, it may be difficult to trace any family likeness between the gigantic Appalachian liquidamber and the dwarfish witch-hazel of Northern regions. The fruit alone is relied upon to determine this. Here will be seen about the same relation existing as between junipers, cedars, and pines. All these are called conifers, although the fruit of the cedar is a berry, yet evidently a berry formed from an undeveloped cone. So the small single or double pods of hamamelis remain closely resembling the several members of the large globular bur of the sweet gum, the great majority of the pistils and ovaries having become abortive.

But not in externals alone is a connection sought to be traced. Those who believe in the importance of a vegetal *materia medica* fondly find in both, similar chemical constituents and properties. These things are disregarded now, when the medical profession, as the fashion is, draw their weapons from the concentrated drugs of the laboratory. But there is a vast population, even in this enlightened age and country, who still use the traditional lore of domestic medicine, handed down to them for generations—some of it derived, as often alleged, from the aborigines. The use of the sweet gum is of this latter class. C. S. Rafinesque (vol. ii., 239), the botanist, thinks its virtues worth recording. As popularly used the leaves are a powerful sudorific, and febrifuge; the bark, chewed, or a decoction made from it, is considered sovereign in dysenteries; and the *gum* or styrax steeped in sweet oil, by which a small portion of it is dissolved, is the *secret* of a popular quackery in use among the people in some places for the cure of many obstinate cutaneous affections. It is also, as well as the bark, often one of the ingredients of poultices for the indolent ulcers so common in malarial districts. We are told it was the incense used in the temples of the Aztecs. To be more particular would be only to be curious without profit.

But there is another use of the styrax which has in it a prospective fortune for some enterprising Yankee or Mississippian, and that is (do not laugh) to make *chewing-gum.* Thousands are spent annually by our youngsters with confectioners for a preparation of gum mastic for *chewing-wax*, as they call it; yet not one of them will touch the commercial article, if he can get a bit of "*gum wax*" from a *country fellow.* And here, to relieve the tedium of such profound science, I had better give, for the benefit of our enterprising Yankee of the future the most approved method of preparing the *gum wax.* All over the piny woods there grow about the slashes and branches several species of smilax, popularly called bamboo briers and *chany* briers. The berries of these (especially the latter) have, connected with the skin, a pellicle of elastic matter, probably genuine caoutchouc. The piny woods boys and girls (I believe the latter excel) are very skillful to detect the best berries, and when properly ripe. These they gather, and after a little mastication are able to spit out the seeds and skins, as well as the disagreeable acid juice, retaining in the mouth only the elastic matter. They are now ready for the sweet gum trees. Armed with the gum elastic, they can use the fresh flowing styrax, as well as the hard inspissated tears they find in any wounds of the bark. Continuous chewing produces a homogeneous whitish substance, very much resembling the prepared mastic. But so different in odor! The sweet gum certainly has a fragrance very agreeable to most persons. A country belle in some sections would think herself as ill furnished without a bit of chewing gum to sweeten her breath, as many another in more stylish circles without her orris root, or eau de Cologne for the handkerchief.

Should our enterprising Yankee contemplate a patent for some method of combining sweet styrax and India-rubber, let us notify him at once that our piny woods girls can chew up and prepare *tons* of the finest wax, more skillfully combined than any machinery he may invent can achieve, which, doubtless, they would be glad to do in exchange for calico.

To obtain the styrax, shallow chops in the bark, or paring off the outside bark to the white part, is sufficient. It is not necessary as in the case of pine to chop into the wood. And this for the reason that the vessels containing or secreting it are found only in the bark, and in the coarser layers of it. At least I have never been able to detect them in the wood. For this purpose, young, vigorous *whitewood* trees are preferable. To pick these out is not a difficult achievement of woodcraft. The size is not the only criterion. *Whitewood* trees are often seen two and three feet through. They abound mostly in second-growth bottoms, and in the vicinity of clearings. As we go north, they become more and more common. Why this is so I do not know: that is, I have no theory. But it is a general law of several kinds of timber. Notably of the tulip tree (*Liriodendron tulipifera*), which in Ohio and other northern localities is called the whitewood tree; at the South it is called yellow poplar.

The readiest mark of whitewood gum is the *appearance* of the bark, known to every youngster who frequents the woods. The bark of the smallest limbs has considerable combs of cork upon it, often an inch in depth, half that very commonly, while the external layers of the trunk bark are also soft and corky. In the old trees the bark of the trunk is hard, rough, and scaly, resembling more the oak, while the corky excrescences of the young limbs and twigs are barely perceptible. Yet the white and the red gum are not different species. A botanist can see no difference in the fruit and in the organs of fructification, nor in the buds and leaves. Whence, then, the difference? A botanist may not be able to tell all the reasons, but he is soon satisfied that age is the principal factor. Nor is this peculiar to the liquidamber tree. It is common in others. Among these might be mentioned all that great family of the Appalachian chain, and of the Himalayas, the Magnoliaceæ, because there is a similarity in the structure of the wood. They are all among the oldest representatives of the angiosperms. Our liquidamber dates back to the Cretaceous period.

Vegetal physiology teaches us that besides the fungi, and the mosses, and ferns, and the lichens, there are at least two great classes of flowering plants, distinguishable in their seeds, their vegetation, and the manner of growth of the stems and leaves. These are technically called endogens and exogens. We may leave out nicer distinctions between these and the cycads and conifers. The endogens grow from within and push outward and upward; the exogens grow by external layers laid on under the bark. Yet not all the species of these several divisions are perfectly alike in the class to which a tree may belong, or to the same *degree* are they either endogenous or exogenous. Hence we find in the conifers a structure common to naked seed plants: the layers of hard wood fibers are laid on in regular concentric rings alternately with the softer cellular tissue. Not so the oaks. With these and all that have the distinct twofold seeds, like acorns, beans, and peas, there is an intermingling of the two kinds of tissues; and all of them have veins or rays proceeding from the pith to the bark. To use the language of M. Louis Figuier, considered authority in such matters: "The trunk [of exogens] is formed of woody bundles of ducts and fibers, arranged round a central pith, forming either concentric rings, or in a *homogeneous* mass, but always having medullary plates radiating from the center to the circumference." ("Veg. Physiology," 344.)

Why all this elementary matter? It is to recall these principles to mind, as a means of explaining this matter of the long continuance of white wood in some trees, while in others of the same species a greater age develops heart wood, and to explain some other things which we will come to directly.

It can be easily conceived in those trees which grow in a *homogeneous mass* from pith to bark that they will continue to use the whole mass for the conduction of sap and the storage of material, such as gum, starch, and sugar. As long as the wood fibers take part in the growth of a tree, they will be white; when dead and deserted by the vital processes, they become dark. When the whole body of the woody tissue is engaged in the circulation of the liquids, the whole continues young and white, like the latest layer.

Now our sweet gum tree has other peculiarities. It is not only *homogeneous* from pith to bark, but has bundles of wood fibers running through it in all directions.

Following the concentric rings, pine splits easily in planes parallel to the bark; following the medullary rays, oak and maple, and even magnolias, split in prism shaped blocks, having the apex at the center. But our sweet gum has no cleavage whatever. It has the medullary rays, or silver grain as plainly as in oaks or maples; but no splitting can be made to follow them. It has bundles and layers of concentric fibers as distinctly as in pines, but they run in different directions, somewhat cross and pile, as if the tree grew alternately in spirals to the right and to the left. Nor is this all? There actually seem to be bundles of fibers, arising from the center, or deep down in the wood, and ascending terminate at the circumference as in endogens. (See Figuier, and plate at page 292.) But as this is a botanical impossibility, I am forced to other conjectures.

This accounts for the warping green or unseasoned red gum timber, and the reputation it bears for being useless on account of this warping. To any practical worker in wood, the diversity of green in a piece of timber signifies different rates of absorption and desiccation, and different rates of desiccation mean that this plank will curve in the direction of those fibers the least compact, and that dry the quickest. So great, it is said, is the warping propensity of unseasoned gum timber, that there is no certainty that the side you lay down uppermost will be found so a month later; that planks of it nailed on a fence will twist themselves off, etc.

But these are the humorous exaggerations of our Western people.

It can be safely laid down as a general proposition not capable of contradiction that *red gum lumber* of the Gulf region, made of the heart wood of the timber, *will never warp at all* if cut at the proper season of the year, when the sap has ceased flowing.

Experience has proved this. Throughout this State you will find in many old homesteads articles of furniture, such as bedsteads, tables, chests of drawers, desks, etc., made from this lumber in the by-gone day when all furniture was made by hand, and before the day of railroads, when heavy articles were with difficulty transported from place to place. These articles compare most favorably in every respect with similar ones manufactured from oak and walnut. In the eastern part of Mississippi, red gum lumber is much used for fences and is preferred to any other on account of its durability. It grows there in its perfection. Perfectly red hearted trees are found as small as one foot in diameter. The planks made from these small trees are preferred for fencing. In Baldwyn, on the premises of Mr. J. W. Burris, is a fence of this lumber which has borne the test of wind and weather for twelve years and more.

It was made of planks 16 feet long and six inches wide, nailed securely to oak posts when unseasoned. Small trees being used, an occasional plank with sap wood edges was found. The edges had rotted off, and *these* planks alone were warped, but out of 100 planks taken consecutively I saw but one warped badly. In those of entire *pure heart wood* no warp could be perceived. *Time* is the most essential factor in the successful seasoning of red gum timber. Let it lie and dry for years, and it can be used for any and every purpose for which walnut and oak can, and will be found quite as manageable. But even if *time* cannot be spared in this fast age to season it properly, the difficulties in the way of success have been much exaggerated, as has been proved by the Mobile Manufacturing Company, which has been making a specialty of this timber. It cannot be seasoned perfectly by the water or steam processes, as other woods are. It does not contain the principles that are affected by these modes of seasoning. The sawing is also one factor in the problem of seasoning. The mills usually cut large timber into quarters, and these into plank. That leaves a corner next the center. There is no hard wood cut this way but will warp away from the pith in drying. If sawed from the whole log, the boards will cup toward the bark, yet this kind of warping is more easily prevented than the other, simply by pressure.

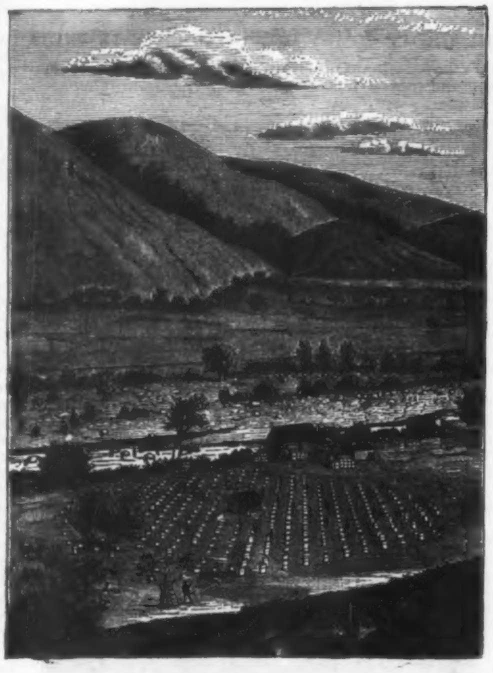
In this factory at Mobile, which has been unfortunately lately destroyed by fire, they found no trouble in preparing this lumber for manipulation by the cabinet makers in as short a time as walnut or oak could be prepared, by subjecting it to process of seasoning in hot air kilns under heavy pressure. In this manner it was made ready for *immediate* use, and could in a few days be worked up in any shape or manner without the least danger of subsequent cracking or shrinking, and gave much satisfaction.

The second proposition that can be safely made, therefore, is that red gum timber, no matter when, or where, or how it is cut, can be seasoned, so it will neither warp nor split, with as little trouble as other woods, although in a somewhat different manner.

Dr. Chas. Mohr, late botanist of the tenth census, has given the timbers of the South much attention, and especially red gum, which he thinks is destined to be *the timber* of the future. In a forthcoming volume of the Census Report, he says that "whatever the objections may be to the use of this timber grown in more northern latitudes and of a younger growth, they lose their force in regard to that of the Gulf region."

Thus it seems that the farther south one goes for this timber the better the article found—that to have the least trouble in preparing it for manufacture, there is not only a certain age when the tree should be cut, but a season of the year when it should be cut out, and also a preferable mode of cutting the same, all of which facts should be considered by lumbermen before making impatient tests of the value of this timber, and then declaring it impossible to overcome an obstacle so small as the seasoning.

The seasoning accomplished, there would yet remain other questions, among them the supply. The settlers of Mississippi have destroyed millions of their capital by the injudicious destruction of their timbers; but millions still remain. Much of the pine is left because the lands were too poor for cotton, but a large proportion of the finest red gum has been destroyed. The problem with planters is not how to preserve, but how to get rid of a tree so difficult to kill. They knew how to belt an oak, and it would die the first season. But trees like gums, having the greater part of the trunk *homogeneous*, are not restricted to a thin layer of white wood to receive moisture and nutrition from the soil. In former times they hacked and hewed at the gums, and built fires around these giants of the bottom lands, to little purpose. As they express it, "Sweet gums will take their own time about dying, anyway." According to more recent practice, gums are as easily killed as any timber. No longer using fire about the roots, they have learned that chopping into the wood the least degree will give opportunity for the great families of insect wood cutters, the *Cerambycidæ* and the *Buprestidæ*, to deposit their eggs at good starting points. By the following fall the whole of the first layers of wood under the bark will be honeycombed from top to bottom by the borers. And the next March, burning off logs, these trees will kindle like tinder, and soon leave nothing but the solid heart wood, not bored materially by the sawyers.



A BEE RANCH.

This deadened timber is the principal source of the present supply of red gum for the saw mills. If really but one year deadened, it will be found not badly injured by the worms.

But the great mass of it is generally so wormeaten that it is fit only for scantling or sheeting. For these purposes it is prized because it holds a nail equal to oak, yet without corroding.

Though immense quantities of this timber have thus given way before King Cotton, an incalculable amount still remains, because, as a fact, gum occupies the heaviest, though the richest, of the low lands. Planters cleared first that which was easiest to clear, and would the soonest become remunerative. Our river bottoms may be divided into three imaginary strips. The lowest are the cypress sloughs, the highest are the white oak ridges, commonly the banks of bayous, and the intermediate flats. The latter are gum lands. Not but many of these trees also grow among the white oaks, as do other trees, and the general growth of the rich flats is also varied. The highest lands, of course, the planters cleared first. But if population increases, the low gum lands will be encroached upon; for all the uplands worth clearing have been cut down and worn out.

For another reason besides getting it out of the way the dead timber mostly get to market: it is so much easier to handle. Green gum is about the heaviest timber of our forests. Some red cypress may be as heavy. This, added to its size, renders the handling of gum no desirable job for the logsman and raftsman. A real red hearted gum is seldom less than three feet through in rich lands; it is often six. I was told by mill men at Vicksburg that green gum is never rafted, from the fact that it does not float except by buoys. Consequently regular green timber does not go down the river. There is always enough of the deadened to supply the demand. Nor would it be found in the rafts, except to float cypress. The latter is generally rafted between alternate logs of ash or dead gum. And so could fresh gum be rafted, and will be, when there is need for it. This there will be when its uses, and fitnesses are fully appreciated. To come back to the uses we may inquire, first, as to its durability. Kept dry, there is no danger of taking dry rot like oak. Hence it has always been considered desirable for wagon fellies, shafts for gin wheels, or any machinery under shelter, from this, and the other fact that it never splits. It is a joke among woodsmen that lightning never strikes a gum tree, because it prefers to strike a tree that it can split.

Again, kept always wet, none excels it in durability. Well diggers say it makes the best water box. It has often been tried for mud sills with success. Probably it would answer well for the bottoms of ships, for it is exceedingly strong, and of that tough, horny kind of strength that it will sooner wear through than crush upon reefs and rocks.

Where merely exposed to the weather, suffering wet and dry, like weather boards of outside walls, and fencing, no timber lasts better. But "between wind and water," as workmen term it, that is, where never wholly dry, nor yet continuously saturated with water, few timbers rot so easily. This defect it shares with many others which are yet renowned for durability. Walnut and chestnut are quite as defective in this particular. Even cypress is not much better than either of them. Hence gum will never do for fence posts, gate posts, and the like.

Looking to its beauty, for, from its peculiar grains and cross grains it takes a finish no other known wood can take, *it is destined in the future to be the timber for inside finish.* The interior finish of churches and dwellings is tending again toward the old mediæval styles of showing the natural wood, instead of the shams of paint and plaster. For these purposes gum must excel. And as carving is again reviving as a means of ornamentation, *none will be found to excel it for that.* It is only rather tough to suit a workman's taste, who would rather have soft pine. But it does not splinter or split; and the carver can bring out designs with almost the sharpness of metal.

Why, then, would it not do for wood engraving? The supply of box is very low, and a subsitute would be hailed with joy by the printers.

For all turned ware it must have peculiar adaptability. Though I have never seen bowls and cups turned of it, for these it must be far more appropriate than elm and maple, in common use. They split easily and take no polish. The posts for the high old fashioned bedsteads, the legs of the old style of heavy dining tables and chairs, desks and settees when made of this timber were considered exceptionally elegant, and of late years the demand for table and chair rounds and stair balusters manufactured from this material is very extensive. It turns readily and smoothly and takes an easy and excellent polish, and on account of its beauty, great strength, and durability is very much sought for. A turning factory in Chattanooga, Tenn., makes a specialty of this timber, and is doing a thriving business.

For furniture, therefore, it must finally rise to the highest place. It has *all* the desirable qualities—fine grain, compact and hard, and yet not so hard as to prevent its being easily worked, durable and strong, taking the finest polish and most elaborate finish, never cracks or splits, and above all is most attractive in color, rivaling walnut and mahogany in this respect. And remember, we have been all this time speaking of what lumbermen call clear stuff—the wood of the trunks alone.

In a mahogany forest as in a gum bottom you find the stems of trees shooting up a straight shaft of 40, 50, and 60 feet without a limb. The product of these tall shafts is all in the case of the gum that has yet gone to market. Of mahogany this clear stuff is of comparatively little value. Up among the branches, the knots contain the wood prized by the cabinet worker. And so with walnut. I have seen hundreds of walnut trees felled, and their large trunks left to rot, while raftsmen cut out only the knotty portions, which they could then afford to haul miles to the rivers, where their buoyant ash logs can be doubled and quadrupled in value by this rich freight. Red gum knots have yet to have a fair trial. The tree does not naturally abound in limbs and branches, like the walnut, but yet of nearly every tree a portion of that sort of lumber may be found. Knots vary all kinds of lumber, and add to the beauty of furniture.

Beautiful strips of moulding intended for ornamenting picture frames or other small work are sometimes to be seen of red gum. I have been told on making inquiry concerning their manufacture that it was a *secret*.

Similiar mouldings are to be seen in the coaches manufactured by the Ohio Falls Car Company, at Jeffersonville, Ind., are much admired, and generally considered to be made of mahogany.

This company says of this wood: "It takes easily an elegant polish and resembles olive. We call it American olive. It forms a splendid contrast with cherry and other woods. When care is taken in its use, it can be used safely and extensively. During the past three years we have used large quantities of it for panels and mouldings in interior decoration."

This is the experience of the only car manufacturing company that has as yet given this wood a fair trial.

When all its many good qualities and few bad ones are taken into consideration, it will be seen that its possibilities are great, and, in view of its present abundance and the rapidly increasing scarcity of cherry, walnut, ash, oak, and other woods which have for so long held sway, it is safe to say that before many years they will have to abdicate in favor of red gum.

CALIFORNIA BEE RANCHES.

THE engraving shows a bee ranch in Ventura County, and presents many features common to the bee farms of Southern California. They are generally little nooks of land near the mountains, which give acres of natural bloom, from which the bees gather their stores. They are quiet retreats, where solitude is rarely broken, save by the monotone of the busy insects or the ripple of the mountain stream which flows by the apiary. The picture shows the arrangements common to the practice of bee-keeping on these farms, of which there are hundreds in the counties of San Diego, San Bernardino, Los Angeles, Ventura, and Santa Barbara. In a good year, when sufficient rain brings a full growth of the natural bee forage plants, the gathering of honey surpasses bee work in any other county where bees are kept, and brings abundance of money to the patient apiarian.—*Min. and Sci. Press.*

A PULLMAN TRAIN FROM CALAIS TO ROME.

All roads lead to Rome, but never until a few days ago did a Pullman palace car travel on any of them. The first Pullman special train for Rome left Calais on Friday, 23d ult., shortly after 2 o'clock, and it reached Rome on Sunday an hour and a half ahead of time, after traveling 1,400 miles without being a minute late at any of the stations at which it was booked to stop. The three palace cars, "Australia," "Castalia," and "Germania," were built at Detroit, and put together and furnished at Derby, so the longest continuous trip ever made in Europe may fairly be termed an Anglo-American enterprise. These cars are destined to run continuously between Rome, Naples, and Reggio, and as they had to be taken to Rome, Mr. H. S. Roberts, European manager of the Pullman Company, determined, if possible, to run the three cars through as a special train, taking any passengers who cared to go *à la* Pullman. The difficulties which Mr. Roberts had to contend with were exceedingly great. In the first place, it was by no means certain that the Pullmans, which are much larger than ordinary carriages, would go through some of the tunnels on the Italian lines. It would have caused considerable annoyance if, when the train was going at fifty miles an hour, it was suddenly discovered that the particular tunnel through which it was going was too small. Trivial as such incidents may seem to an outsider, they have to be taken into account by the careful railroad man. No right-minded person desires to smash up other people's tunnels. If there is anything an Italian railway manager loves, it is a nice tunnel. Along the Apennines there is a tunnel every few rods. There are tunnels of all sizes, from the seven-mile Mont Cenis to the one which is like a flash of black lightning. The most captious person could find no fault with the assortment of tunnels these enterprising Italians provide for their patrons. Tunnels come high, especially those at the tops of the mountain, but the Hightalians must have them, and consequently they would object to having any of the inside frescoing taken off by a Pullman train.

Another matter for consideration was the curves. The long Pullman car does not particularly like a short curve. History tells us that once when a bridge over a Swiss chasm was thought to be unsafe, the Highpanjandrum of the canton hit on a happy method of testing its stability. He got all the people the bridge would carry to stand on it, and as it did not go down it was pronounced safe. In like manner Mr. Roberts might have swung his train around the curves, and if it did not break or run off the track, the curve question might have been dismissed. However, he did not adopt this enterprising method, but took the slower plan of going over the ground and making measurements and calculations, and finally it was agreed that the Pullman would go over the road without straightening a curve or taking any of the decorations off a tunnel.

There were other difficulties in the way that required some diplomacy to get over. The officials of some of the foreign railways were at first averse to allowing any person to run a special passenger train over their roads. But at last all obstacles were overcome, and Mr. Roberts turned his whole attention toward getting everything in perfect order for the trip. The cars were taken over from London to Calais by steamer, and placed on the rails in readiness a few days before the start was made. The weather throughout the trip was all that could be desired. The passengers were mostly from England, several gentlemen having their wives with them, and to these were assigned the private state-rooms with which each car is provided. By general consent the center Pullman was used as a smoking car, although each car contains a smoking room.

The train consisted of the engine, a luggage-van and three Pullmans, another luggage-van, and last a sort of guard's car. It left Calais at about 2:30 on the 23d, after having been an object of great curiosity to a large crowd of sight-seers, who collected at the station and along the railway.

M. Thouin and M. Delebeque, of the Northern of France Railway, came on at Calais. At Boulogne, which was reached in about three-quarters of an hour, the other officials joined the train, while a number more got on board at Amiens. When Paris was reached, the train was taken over part of the Circular Railway to the Lyons station, where all got out, at 8:40, to demolish a dinner that had been telegraphed for. If the passengers had any money left with which to continue their journey, it must have been through some oversight on the part of the person who runs the restaurant. He certainly made a vigorous effort to scoop in the wealth of the crowd. Shortly after Paris was left the cars were quickly transformed from day to night coaches. Many of the railway officials left at Paris, but others joined, so the number in the train was always about the same.

Among those who got on at Paris were M. Hottinger and M. De Varu, directors of the Nord Railway; M. Meissonier, the Railway Superintendent of the Public Works in France, and M. Banderail, Locomotive Superintendent of the Northern of France, together with M. Noblemaire, General Manager, M. Picard, Traffic Manager, and M. Henri, Locomotive Superintendent, all of the Lyons Railway.

A stop of a few minutes was made at Dijon at 5 in the morning, and again at Macon for a cup of coffee. The engineer of the locomotive, who was interviewed here as to how he found the cars run, said that he was never in charge of a train that behaved so well. He seemed to think that with ordinary care the Pullmans might be taught to run alone. At Culoz, among the snow-covered mountains, a stop was made at 10:36 for breakfast; after this meal the delighted passengers desired the Detroit *Free Press* to announce to the world that a Culoz breakfast stands unrivaled. It was sumptuous; lack of space prevents the enumeration of all its merits, but these will be touched up some other time. Modane was reached at 8:35, and besides changing locomotives the time of Paris was exchanged for that of Rome. Very appropriately, the stout engine "Hannibal" took hold of the train to lead it over the Alps. This engine had four small wheels on each side, and was evidently constructed more for strength than for speed. As Hannibal never entered Rome, neither does this engine. It is satisfied with crossing and recrossing the Alps, an occupation in which the spirit of the original Hannibal probably delights, unless, like the ghost of Hamlet's father, he is condemned to (k)nightly walk these heights, in which case he, no doubt, grumbles considerably.

At Modane, M. Bachelet, Traffic Superintendent of the Alta Italia Railroad, came aboard. Old "Hannibal" took us through the depths of the Mont Cenis Tunnel in 26 minutes, and at 9:20 Saturday night the train passed into the great glass arch of the Turin railway station, "the largest station in the world"—a distinction which it shares with about a score of other stations.

Here President Blumenthal and Assistant General Manager Ratti, of the Alta Italia Railroad, joined the party.

After leaving Turin we once more "pitched our moving tent a day's march nearer Rome," and everybody said next morning that they never slept better in their lives.

Sunday morning found the train rattling along among the Apennines. While in the Alps the sleighing had been excellent, if there had been any one with sleighs to enjoy it, but in the Apennines there was not much snow, except at the extreme tops of the mountains.

Manager Roberts had based his calculation on clear tunnels, and he was therefore appalled to find on the top of the Apennines that one tunnel was under repair, and was almost filled with timber arching, leaving just enough room for the ordinary train to pass. Here was a "go," or rather, it threatened to be no go. After a great deal of slow and cautious work, the train was at last got through, although if the tunnel had not been a short and straight one there might have been a stick, as the long cars could not have turned in a crooked, timbered tunnel. At Bologna a few minutes were allowed in order that sausages might be obtained, and Florence was reached at 10. After this the course lay along the Arno, and doubtless the anxious manager, who at last freed his mind from fears of "hot boxes" or timbered tunnels, thought "after this there Arno more troubles from here to Rome." It was for making this pun that Julius Cæsar was slain, and that was why no jury could be got to convict the murderers.

Mr. Willing, the celebrated advertising contractor of London, was a passenger, and he had with him a great quantity of gilded advertising medals that looked like sovereigns. For once the Italian beggars along the route found a man as Willing to give as they were to receive. With liberal hand he flung the yellow tokens among the crowds, and the scramblings that ensued were some of the most stirring scenes of the trip.

The dome of St. Peter's was sighted just as the last rays of the setting sun shone on it, and soon the whole city appeared to the travelers. Be it ever so gorgeous there is no place like Rome. The train reached the station more than an hour and a half ahead of time. Among those assembled to see it arrive was Monsignore Capel, who occupies such a prominent position in Disraeli's novel of "Lothair." He warmly congratulated Mr. Roberts on his success in bringing through the first Pullman train to Rome. The run was the longest continuous trip ever made by a train in Europe. The speed averaged about thirty miles an hour, exclusive of stops. The cars will now run regularly between Rome, Naples, and Reggio.

This rough sketch is written in Rome, and is hurried through in order to catch the English and American mail. The writer reserves all rights to return to the subject and give in detail some of the incidents of the trip.—*Correspondence Detroit Free Press.*

[The Steamship.]

THE MANCHESTER SHIP CANAL.

The Manchester Ship Canal may be considered not only a certainty in the immediate future, but settled in all its prominent features. The bill will be doubtless obtained in the ensuing Parliamentary session; and we therefore propose to submit a general description of a scheme which will so greatly alter the destination of an immense quantity of tonnage now entered or cleared at London, Hull, and, above all, Liverpool.

The original idea proposed by Mr. Fulton, and entertained by the preliminary committee, was to deepen and widen those rivers so as to have a real tidal waterway, devoid of locks or other impediments of navigation from the bar at the mouth of the Mersey to the docks at Manchester, fifty miles inland—in fact, to turn the Irwell into a Clyde or Thames. But rigid examination and surveys dispelled the "fascinating" idea, and led to the final adoption of the scheme drawn up by Mr. E. Leader Williams, C.E., and approved by Mr. James Abernethy, C.E., perhaps the first living hydraulic engineer.

The construction of a semi-tidal canal obviates almost every difficulty suggested. If the goods have to be lifted by artificial means to the level of the Manchester streets, no mode is so quick, so cheap, or so safe as lifting ship and all by the utilization of natural water power in a lock. The cost of the necessary locks will be much less than the saving effected in excavating, and in the smaller amount of land required through the saving of large slopes. The upper part of the navigation will be still-water pounds, navigable at all times, and which may be at any point widened into docks. Great facilities will be afforded for the discharge of the sewage and chemical impurities of a densely crowded manufacturing neighborhood. The docks and channel can be thoroughly scoured, while flood water, which has recently disastrously affected the low lying parts of Salford and other towns on the banks, will be effectively disposed of. In fact, the only difficulties of any importance to be faced are the carrying the various railway lines and the Bridgewater Canal across the channel so as to interfere as little as possible, if at all, with the overhead traffic.

Mr. Williams then proposes "to continue the tidal river from Garston to Latchford above Warrington, and above that point to Manchester, a distance of fifteen miles, to construct a ship canal with locks to raise the water level to nearly its present height at the proposed site of the docks at Manchester."

The Mersey, between Warrington and Runcorn, winds through marsh land partly covered with water at high tides. It widens out considerably at Runcorn, narrowing again as it passes under the London and Northwestern Railway bridge at Runcorn Gap. The length of the present course is eleven and one-half miles, but by cutting off bends and confining the river to a series of easy courses, the length will be reduced to eight miles. From Runcorn to below Garston the course of the river is at present very variable. Mr. Williams states that he has known it to shift as much as a mile in a few days. Throughout this distance the stream will be confined to a fixed course, and the channel deepened by training walls and dredging. The training walls, to be constructed of rubble stone from the cuttings above Warrington, will be of such a height as to maintain a low-water channel in one defined course without interfering with the free flow of the tide over the surrounding sand banks. "As soon," proceeds the report, "as the ebb and flow of the tide is fixed in one course, steam dredgers will be used to dredge out the channel to the full depth of 22 feet at low water; the result of the dredging will be to lower the low-water line at Runcorn 12 feet and 17½ feet at Warrington, thus making room for a column of tidal water which will be of great service in scouring the lower channel and the Bar."

The deposited plans of the canal proper are slightly altered from the original design. Instead of the tidal section proceeding in a series of bends to Latchford, it will run in an approximately straight line to Lower Walton, where the first set of locks will be situated. The locks consist of a group of three, side by side and parallel to each other; while intermediate gates will be provided for each lock, so as to allow of the larger locks being used for shorter vessels or barges, without waste of water. Through a similar group of locks on the Amsterdam Ship Canal nearly 700 vessels of different sizes have been passed in one day, and as the largest locks will hold several vessels, or a tug and a large train of barges at once, detention need not be feared. The gates and sluices will be worked by means of hydraulic power, for which the fall at the locks will be utilized. The pound from these Lower Walton Locks to the next set at Irlam will be semi-tidal; that is, the water-level will be rather under that of high water. At this period (except at very low tides) the lock-gates, special tidal-gates, and flood-sluices will be allowed to stand open, leaving a clear waterway. As soon as the tide turns on the ebb, the gates and sluices will be closed, and the level of high water maintained in the whole reach of eight miles. The canal between Lower Walton and Manchester will have a bottom width of 100 feet, being 28 feet wider than the Suez Canal and 13 feet more than the Amsterdam Canal. It will thus be possible for the largest vessels to pass each other at any point. A large dock, to serve Warrington, will be constructed at Latchford, entered from the canal by locks, and extending back to the old bed of the Mersey.

The second group of locks will be located at Irlam, above the points where the Cheshire lines cross the route, and the junction of the Mersey and Irwell. None of the railway bridges therefore will have a higher water level under them than that of high tides. Four miles above Irlam, beyond the aqueduct by which the Bridgewater Canal is carried over the river, are placed the Barton Locks, which pen back the water to the level of the proposed Manchester Docks, a distance of three miles. This level will, by means of these two sets of locks, be 35 feet above ordinary spring tides at Irlam, which will be 8 feet less than the present level of the river below Throstle Nest Bridge at Salford. In ordinary seasons the river will afford an ample supply of water for these locks, but it is proposed to excavate the channel four feet lower than will be required for the purposes of navigation, so that the surplus depth may act as large reservoirs in dry weather. A conduit also will be cut from the Mersey to the Irlam pound, above Irlam Locks, through which a supply can be derived if required. Auxiliary steam power will be supplied to the locks in case of deficiency of water at any time.

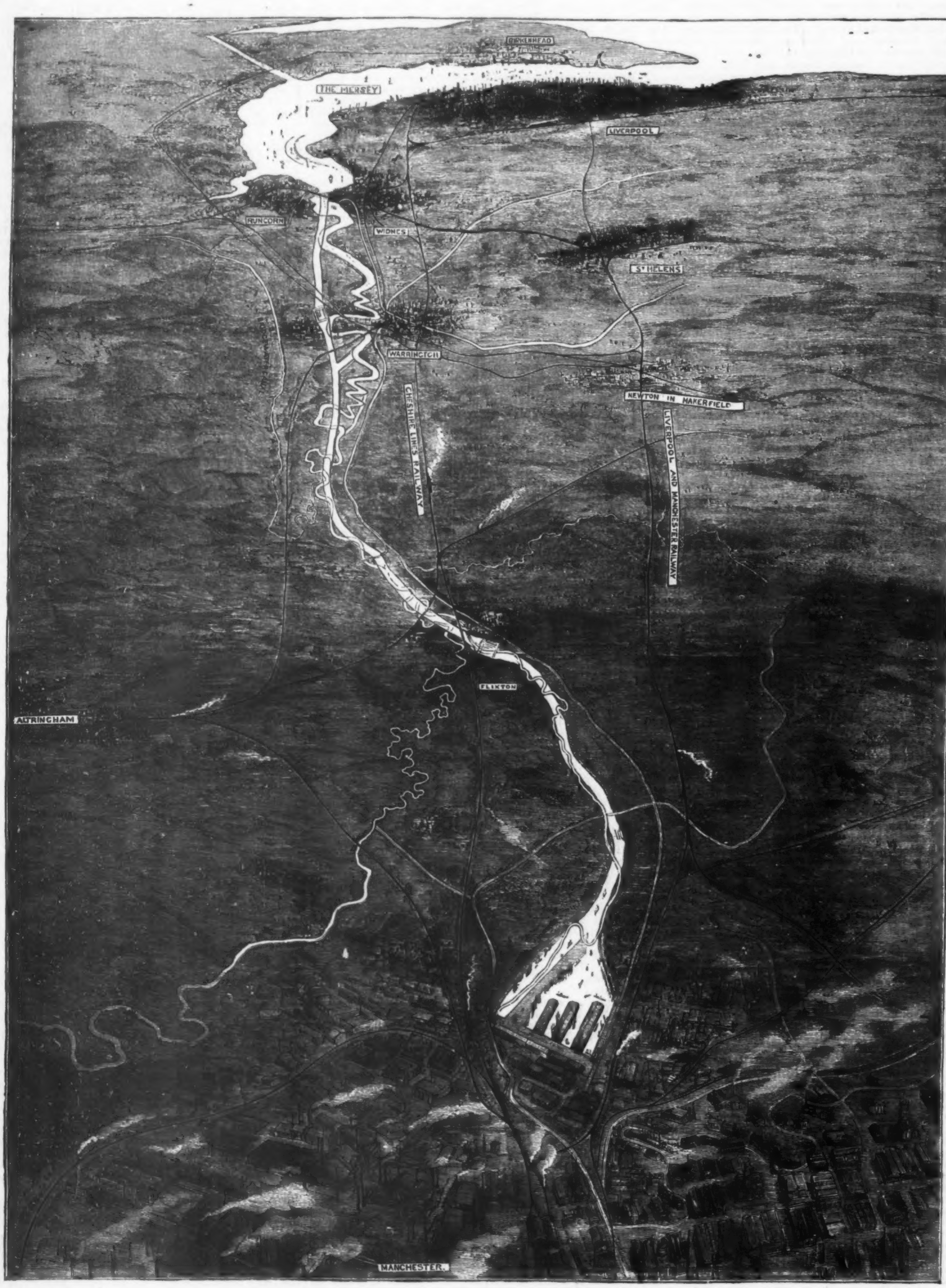
The plan of dock accommodation at Salford embraces two schemes. By one of these the existing river channel, which will be maintained for the passage of floods, will be straigtened by constructing a quay wall on the Salford side and widened to 300 feet, forming a large float with an area of 100 acres, and quay space of four miles in length for coasting vessels. The other and more important work is the construction of a large dock on the site of the present racecourse and adjoining land. This ground is level, there are no buildings upon it, and there is ample room for future extension. The large dock will be 70 acres in extent; the entrance, near the present Mode Wheel Weir, being provided with gates 80 feet wide, which can be closed in flood time, or when the river is lowered for scouring purposes. The dock gradually enlarges out until it is 1,350 feet wide, where four branch docks will extend out of the large dock on the modern system lately adopted at London, Hull, and Liverpool. These subsidiary docks will be separated from each other by wide quays covered with sheds. The ordinary height of water in the docks will be 8 feet below the quay, which will itself be 8 feet below the present ground. Land is scheduled in the neighborhood for extensions, and also for graving docks and repairing purposes, to provide for the frequent overhauling required by cotton ships, which would, if not thus accommodated, have to put into Liverpool to refit. The docks are most favorably situated as a distributing center, being within half a mile of five separate railway lines—the London and Northwestern, the Cheshire lines, the Lancashire and Yorkshire, the Didsbury and Stockport, and the Manchester South Junction and Altrincham.

The most important engineering problem connected with the scheme—next to the cutting of the canal itself—is the providing for the cross traffic which now exists between the two sides of the river. Four roads—one at Barton, one at Warburton, and two at Warrington—cross the river. These will have to be raised or provided with swing bridges. At Barton, the aqueduct of the Bridgewater Canal, chiefly used for coal traffic, crosses the river. Mr. Williams proposes to construct a new aqueduct, the center portion of which will be a wrought iron caisson, kept full of water, which will swing on a central pier in a similar way to a railway swing-bridge, leaving a wide opening for the passage of vessels on either side. This will not be difficult, the present aqueduct being only wide enough to allow one boat to pass. There will be lifting gates at each end of the caisson, and also at each end of the aqueduct, so that when all the gates are closed the caisson can be moved round by hydraulic power without loss of water. The weight and pressure at all points being the same, a boat may remain in the caisson while being swung, and thus there will be no occasion for delay in opening. The water tight joints will be of thick India-rubber, closed by pressure similar to an arrangement designed by Mr. Williams for the Anderton Boat Lift on the river Weaver Navigation, where boats floating in a caisson are lifted by hydraulic power from that river to the Trent and Mersey Canal, fifty-two feet high, in three minutes.

The first railway bridge, coming from Liverpool, is the Runcorn Viaduct on the London and Northwestern Railway. This has at present a clear headway at high spring tides of 75 feet. The headway will average 90 feet at the state of tide when most vessels will pass the bridge, and this height will allow of sailing vessels of large size passing under with their top-masts and topgallant-masts struck, which, as these vessels will always be towed, will not interfere with their progress. In the same way the largest steamers can pass, and thus Runcorn Viaduct need not be interfered with.

There are, however, five other railway bridges, three near Warrington and two near Irlam, which will give more trouble.

With respect to every one of these five bridges—namely, three on the London and Northwestern Railway at Warrington, and two on the Cheshire Lines near Irlam—Parliament had previously enforced the adoption of a clause providing that a swing bridge shall be substituted if the Mersey and Irwell navigation is made available for sea-going vessels. The original report contented itself with pointing out that, although the railway companies are bound by the bar-



THE PROPOSED MANCHESTER SHIP-CANAL.

The Manchester Ship-Canal is estimated to cost between £5,000,000 and £6,000,000. It will be fifty miles long from the sea to the **Manchester Docks**, and the engineers believe that the work could be finished in four years. The rivers Irwell and Mersey would be partly utilized for the New Canal, which will join the estuary of the Mersey at Runcorn. From that place a low-water channel must be dredged for ten miles in the quicksands of the estuary of the Mersey to connect the inland canal with the sea. The promoters of the scheme claim that it will enormously stimulate the trade, not only of Manchester and Salford, with their population of 400,000, but of the whole of Lancashire. On the other hand, the Canal will be strongly opposed by several railway companies, whose levels will have to be altered if the Canal is to be made.—*Graphic.*

gain thus made, it does not follow that, if they are ready to meet the question fairly and alter the levels of their lines, swing bridges might not be avoided, as the level of the river will be lowered considerably. It is manifest that, as on one of the London and Northwestern bridges alone two hundred trains cross daily, and as the company's main line runs by Warrington, great inconvenience would result not only to the railway, but to the public by the adoption of a swing bridge. Advantage would, therefore, accrue to either side by evincing a disposition to meet each other half way, and so both enlisting the sympathy of the public. Were the canal promoters to push the railway companies into too close a corner, they might find the latter develop unexpected powers of fight, and themselves placed under correspondingly stringent conditions. Mr. Williams suggests that duplicate lines might be constructed at some distance apart from each other, with a swing bridge to either line, one of which might be always kept closed for the passage of trains; or, as an alternative, tunnels might be used under the bed of the river. As he points out in a spirit of warning, not only was the London and Northwestern Railway compelled to cross the river at Runcorn at a great cost, but the Corporation of Liverpool two years ago were obliged to agree to put their new water mains from North Wales at a depth to be determined by the Board of Trade, with a view to future improvements in the navigation. Thus for many years past future improvements of the navigation have been protected by legislation; and as Parliament has hitherto continuously and uniformly prevented railway companies from putting any bar in the way of improvements of inland navigation, the promoters do not anticipate that these clauses will be rendered nugatory at a time when it is universally acknowledged that our inland navigations should, following the example of other countries, be thoroughly developed.

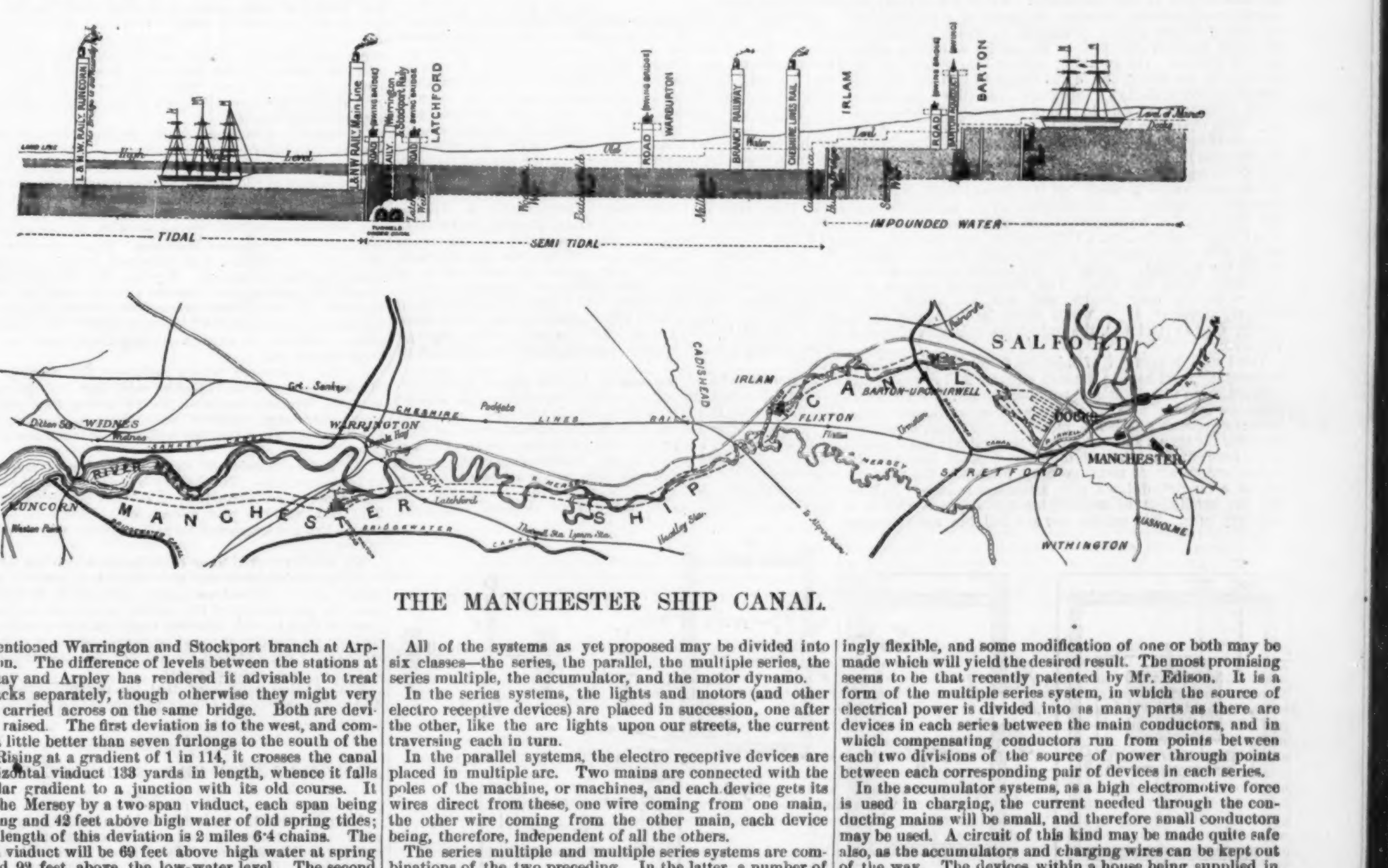
In the final plans, all idea of swing bridges is abandoned. The first track encountered, as we pass upward from Runcorn, is the London and Northwestern main line from Crewe. This crosses the river by the Walton Bridge, and cuts the Warrington and Stockport branch nearly at right angles at Bank Quay Station. The second track is the Birkenhead, Lancashire, and Cheshire Junction Railway, which, after running nearly parallel to the first and crossing the river by the second Walton Bridge, turns eastward and joins the above mentioned Warrington and Stockport branch at Arpley Station. The difference of levels between the stations at Bank Quay and Arpley has rendered it advisable to treat these tracks separately, though otherwise they might very easily be carried across on the same bridge. Both are deviated and raised. The first deviation is to the west, and commences a little better than seven furlongs to the south of the canal. Rising at a gradient of 1 in 114, it crosses the canal by a horizontal viaduct 133 yards in length, whence it falls at a similar gradient to a junction with its old course. It crosses the Mersey by a two span viaduct, each span being 90 feet long and 42 feet above high water of old spring tides; the total length of this deviation is 2 miles 6·4 chains. The principal viaduct will be 69 feet above high water at spring tides, and 93 feet above the low-water level. The second deviation also rises by a gradient of 1 in 114 to the viaduct, which is in this instance 385 yards in length, its height above the water level in the canal being the same as in the first case. It falls toward the junction with the Warrington and Stockport Railway at a rate of 1 in 105, and the total length is 2 miles 1 furlong 3 chains.

The Warrington and Stockport track itself, which crosses above the locks, is also deviated, but lowered. Commencing 5½ furlongs south of the canal, this deviation falls at a rate of 1 in 60 to a depth of 46½ feet below low-water level of the canal. This it passes under by a tunnel 165 yards in length, afterward rising at first at the rate of 1 in 60, and latterly at a gentler inclination to rejoin the present route. The total length is 1 mile 6 furlongs 1 chain.

The Cheshire lines' tracks cross the canal, one at 13⅛ miles, the other at 14¾ miles above Walton locks. These are to be deviated and raised in a manner similar to the London and Northwestern lines just described. The first of these deviations on the Liverpool and Stockport Railway will be 1 mile 7 furlongs in length; the latter on the Liverpool and Manchester Railway will be 1 mile 6½ furlongs. In both cases the gradients will be 1 in 114, and the viaducts will raise the tracks 40 feet above their present level.

The engineering details of this great scheme will, we hope, be more fully appreciated by the engravings we present in our current issue. These will be seen to comprise a plan, showing not only the proposed course of the ship canal, but the various railways, rivers, and subsidiary canals to which reference has been made. The line of canal itself is shown by the thick broken lines from Runcorn to the docks at Salford.

Accompanying the plan is a sectional elevation indicating the canal levels, and the proportionate heights of the various bridges and depths of the tunnels. The reaches wherein the water will be tidal, semi-tidal, and wholly impounded are delineated by different styles of hatching. The uppermost broken line gives the levels of the present navigation, the weirs being shown, and designated by their respective names. The top continuous line is the land line, and gives some idea of the amount of excavation necessary. The two Walton bridges are so close together that they are represented by one viaduct. The drawings are so clear as not to require any further detailed explanation, and they will, we trust, furnish our readers with an adequate conception of the proposed works.



THE MANCHESTER SHIP CANAL.

THE ELECTRIC DISTRIBUTION OF POWER.

By BRADLEY A. FISKE, U. S. N.

THAT the time is near at hand when our cities will be supplied by night with electric light, and by day with electric power with which to work printing presses, turn lathes, propel cars, etc., there can now be no reasonable doubt; but neither, on the other hand, can there be any reasonable doubt that many problems still remain unsolved that bear upon the subject in the most practical way, and that, until these problems are solved, no plans for extensively distributing light and power can ever take a practicable shape. Yet, in proportion to the difficulties to be encountered are the rewards to be achieved. Our cities must get light and power in more convenient and economical forms than those now in use; it remains for inventors and electricians to find the way.

In dealing with this matter, it will be necessary for the inventor to be on his guard at the outset against vague conceptions and general ideas. The subject is a very precise and practical one, and must be attacked in a very precise and practical way. A plain statement of the methods already patented, with the advantages and disadvantages of each, may assist some in deciding in which direction it is best to work.

All of the systems as yet proposed may be divided into six classes—the series, the parallel, the multiple series, the series multiple, the accumulator, and the motor dynamo.

In the series systems, the lights and motors (and other electro receptive devices) are placed in succession, one after the other, like the arc lights upon our streets, the current traversing each in turn.

In the parallel systems, the electro receptive devices are placed in multiple arc. Two mains are connected with the poles of the machine, or machines, and each device gets its wires direct from these, one wire coming from one main, the other wire coming from the other main, each device being, therefore, independent of all the others.

The series multiple and multiple series systems are combinations of the two preceding. In the latter, a number of electro receptive devices are placed in the main circuit, but are in multiple arc, or parallel, to each other; that is, the main circuit is split at a certain point into a number of branches which pass through the electro receptive devices, and then reunite. Further on, at the next house, for instance, the circuit is again split into a number of branches equal to the number of devices to be fed. Thus each group is composed of devices parallel to each other, while the groups themselves are placed in series. The series multiple systems are modifications of these, in that each branch, instead of containing only one device, contains a number of devices in series. The branches, in other words, are in multiple arc to each other, but feed devices in series. The groups, as in the multiple series systems, are in series.

In the accumulator systems, the devices for any space—a house, for instance—are placed in multiple arc, and are fed direct from accumulators near at hand, the accumulators being fed by a charging circuit containing many similar groups of accumulators, and proceeding from a powerful dynamo.

In the motor-dynamo systems the arrangements are much the same, except that motors actuating dynamos take the place of accumulators. The motors are placed in series upon a long charging circuit, and caused to revolve thereby. Each motor is connected mechanically to a dynamo, which, in revolving, generates a current, which feeds devices placed in multiple arc.

From the standpoint of economy alone, the series systems possess unquestioned advantages over all the others. The reason for this is, that, where devices are placed in succession, the current required for the whole circuit is only that required for one. This does not mean that it is as cheap to supply all as to supply one, for it is evident that the resistance of the whole circuit will be very great, being the sum of all the individual resistances placed therein. But these resistances can be overcome by increasing the electromotive force of the generator. Now, by transmitting a current of small quantity, but high electromotive force, along a conductor, we do not lose much power in the form of heat in said conductor, and, therefore, we may use one of small diameter. In view of the high cost of copper and the great length necessary in any extended circuit, the economy thus obtained is a powerful consideration. The disadvantages of the series systems are that each device is dependent for its supply upon the integrity of the whole system (for a break in any part of the circuit stops the whole current), and that to send a current of the high potential necessary through a populous district would be dangerous to life in the highest degree.

In the parallel systems, we find a state of affairs exactly the reverse. Here, as each device gets its current direct from the mains, a very low electromotive force will suffice, being that necessary for one device. Thus, we get the advantages of perfect safety, of simplicity, and of thorough independence of all the devices of each other. But, on the other hand, we find the disadvantage of great expense, for the following reason: As each lamp gets its current independently, the current carried by the mains will have to be equal to the sum of all the currents. Now the heating effect of the electric current is as the square of the current, and the effect of heat being to increase the resistance, it becomes essential to have conductors large enough to keep cool under the passage of the required current. Considering the high price of copper, and remembering that earth must not be used as a return, but a separate conductor employed, it does not take a very elaborate calculation to convince us that, for a parallel system over an extended district, the cost of the copper mains alone would be so great as to make the undertaking one of very questionable practicability.

The series multiple and multiple series systems endeavor to combine the economy of the series systems with the safety and reliability of the multiple or parallel systems, but, as yet, not very satisfactorily. They are evidently, however, exceedingly flexible, and some modification of one or both may be made which will yield the desired result. The most promising seems to be that recently patented by Mr. Edison. It is a form of the multiple series system, in which the source of electrical power is divided into as many parts as there are devices in each series between the main conductors, and in which compensating conductors run from points between each two divisions of the source of power through points between each corresponding pair of devices in each series.

In the accumulator systems, as a high electromotive force is used in charging, the current needed through the conducting mains will be small, and therefore small conductors may be used. A circuit of this kind may be made quite safe also, as the accumulators and charging wires can be kept out of the way. The devices within a house being supplied in multiple arc, the electromotive force traversing the wires of a house will be very low and safe, and the current very steady. The only disadvantages lie in the facts that accumulators, in the present state of the art, are very high in price, are very heavy indeed, furnish individually so small an electromotive force that many are needed to overcome the resistance of one incandescence lamp, and that they do not yield a large percentage of the power stored in them. In the future, however, these defects will doubtless be remedied to a great degree.

In the motor-dynamo systems, it is intended to have each motor-dynamo supply an area of such an extent that its conducting mains will not be very large on the one hand, and that too great a number of motor-dynamos will not be required for an extended district on the other hand. The advantages of this system, like those of the accumulator system, are obvious. But it remains to be seen whether or not the losses of energy in the circuit will be too great to destroy its practicability. Clearly, there is a twofold loss at each motor-dynamo, the loss in converting the electrical energy of the charging circuit into the mechanical energy of the motor, and the loss in converting the mechanical energy of the motor into the electrical energy generated by the motor-dynamo. The cost of the motor-dynamos, is, of course, also to be taken into consideration.

Thus, it will be seen that, in spite of the wonderful development of the practical applications of electricity during the past few years, we have not as yet attained perfection in the art, or even approached it. Many mistakes must

be rectified, many inventions must be made, many failures doubtless must ensue, before success shall finally triumph, and give us a perfect system of distribution of electric light and power.

NEW TELEPHONE TRANSMITTERS.

At a recent meeting of the Society of Telegraph Engineers and of Electricians, London, a paper was read by Mr. J. Munro on "New Telephone Transmitters." The author commenced his paper by stating that, in order to avoid the Edison patent, it was necessary to avoid the use of carbon, and probably even of any semi-conductor. The author was of opinion that the action of the microphone was not due to the diminution of resistance at the points of contact by pressure, causing greater or less area of surface contact, according to the current theory at that time. It seemed to him that the film of air between the contact points played an important part in its action, and that the electrodes of a microphone might be of any conducting substance—for example, metals—without destroying its peculiar power of transmitting sounds. What

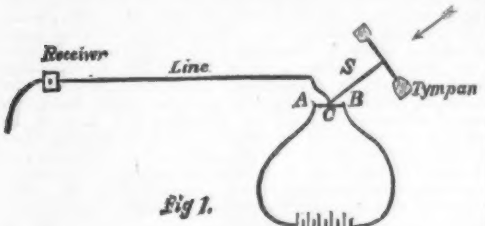


Fig 1.

kind of metal to use and what particular form to give it, in order to get good articulation and durability of action, were questions which only experiment could answer. In working out any ideas on the subject, the author worked in conjunction with Mr. Benjamin Warwick. One of the first ideas tried is shown in Fig. 1, and though it proved a failure it was instructive in one particular. AB is a fine short platinum wire connected between the poles of a battery, and carrying a sliding contact or chariot, C, which is connected by a light but stiff stylus, S, to the center of a mica drumhead or tympan. On speaking against the tympan in the direction of the arrow, the stylus shoots to and fro like the recording pen in Barlow's logograph, and slides the chariot C, up and down the wire to points of greater or less potential. This chariot is connected to one end of the line, which has a receiver at the other end. When there is no circuit through the line, and the device acts by varying the potential of the transmitting end of the line, a Dolbear receiver or a condenser would be used; but if a shunt circuit is formed between the chariot, C, and one pole of the battery through the "primary" of an induction coil, while the "secondary" is in circuit with the line, a Bell receiver may be used. On trying this plan, however, it was found that the current varied too regularly, owing to the chariot always moving in contact with the wire. The strength of current was thus varied by easy grades, and was not quickly and abruptly changed, as it needs must be in a good transmitter, so as to render all the sudden irregularities of speech vibration.

Tried with a tympan of mica or ferrotype-plate, placed horizontally, and having a short angular stylus projecting upward from its middle and rubbing up and down a short platinum-iridium wire in circuit with seven Bunsen cells, imperfect speech was heard in a Bell telephone connected between the stylus and one pole of the battery; but it might have been due to the microphonic contact between the stylus and wire. A mercury drop, inclosing the wire, to act as a chariot, did not give articulate sounds. Neither did the oscillation of mercury up and down a wire in a capillary tube. The sudden rise and fall, the sheer descent

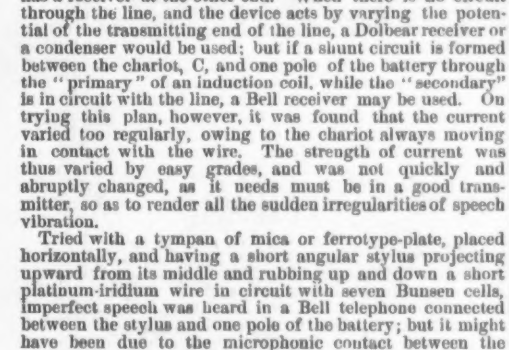


Fig. 4.—THE GAUZE TRANSMITTER.

of current, which is required for the transmission of speech, could not be given by such a device. The use of wires in these experiments led the author to the idea of employing two light wire gratings resting on each other under slight pressure, and forming a metal microphone with multiple points. It seemed that the light open structure would allow the sound-waves to agitate the contacts without the intervention of a tympan, and something after the manner of an Æolian harp.

Fig. 4 is a transmitter made on this plan. It consists externally of a wooden box, B, having a mouthpiece, M, closed by a piece of match-wood. Inside the box is the microphone, or "current-regulator," which consists of a piece of ordinary iron-wire gauze, g, lightly pressed against another piece, g^1. The back piece of gauze, g^1, is fixed to the back of the case, but the front piece, g, is carried by a loose axle, $a\,a$, supported in bearings at each end. From the axle projects an arm, carrying a movable counterweight, W, and the downward pull of this weight, tending to lift the front gauze off the back, is balanced by the force of an adjustable spring, S. The pressure on the microphonic contacts is regulated by this means. The stops, $p\,p$, serve to limit the sidelong play of the axle carrying the movable gauze, when it is found convenient to shift the position of the latter in adjusting the instrument. The current enters and leaves the regulator by the terminals, $t\,t^1$. A small induction coil (not shown) is usually inserted between the transmitter and the line, the "primary" of the coil being in circuit with the battery and the regulator, while the "secondary" is in circuit with the line-wire and receiving telephone.

On speaking into the mouthpiece in the usual manner the air-waves set up by the voice pass through the two gauzes and agitate the contacts between them, thereby modifying the current so as to make the telephone repeat the words. The match-board diaphragm is not an essential, as the sound-waves act directly on the contacts, but it is useful in screening the regulator from the rudeness of the breath, and fixing the distance at which they should keep. A grating across the mouthpiece answers almost as well.

The pole of a permanent magnet presented to the gauzes will hold them together with a force depending on the nearness of the pole. When an electro-magnet, E, is used, as in Fig. 5, the current itself may traverse the coil of the magnet, and hold the gauze, g, against g' with a force which will be stronger when the current is stronger, and thus enhance the pressure of the sound-waves, so as to give a more decisive action. It was found that the gauze may be either clean or

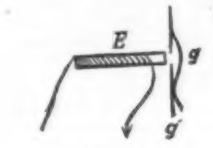


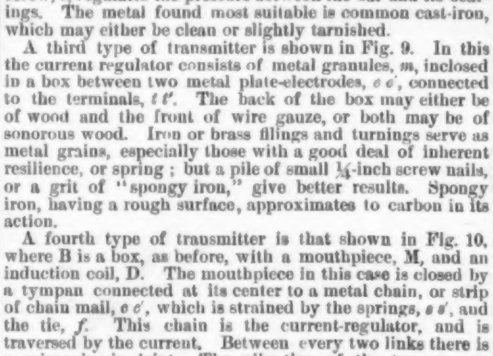
Fig. 5

tarnished, provided the rust upon it is not so thick as to make the surfaces adhere to each other. Two pieces of gauze are not essential to the transmission of sounds, as one piece resting on a flat metal plate, either plain or corrugated, will answer; so also will two thin metal plates with roughened surfaces. But gauze is the most convenient and successful material.

Another type of metal transmitters is shown in Figs. 6, 7, and 8. There B is the case, as before, with a match-board screen, M, and behind it a flat sounding board carrying a metal microphone, i, with its adjusting spring, S. An induction coil, D, having its "primary" in circuit with the microphone and battery, and its secondary in circuit with the line, is also contained in the case. The microphone is formed of a light metal bar, i', resting by its ends in holes drilled in two metal blocks, $i\,i''$, Figs. 7 and 8. An adjusting screw, s, regulates the pressure between the bar and its bearings. The metal found most suitable is common cast-iron, which may either be clean or slightly tarnished.

A third type of transmitter is shown in Fig. 9. In this the current regulator consists of metal granules, m, inclosed in a box between two metal plate-electrodes, $e\,e'$, connected to the terminals, $t\,t'$. The back of the box may either be of wood and the front of wire gauze, or both may be of sonorous wood. Iron or brass filings and turnings serve as metal grains, especially those with a good deal of inherent resilience, or spring; but a pile of small ¼-inch screw nails, or a grit of "spongy iron," give better results. Spongy iron, having a rough surface, approximates to carbon in its action.

A fourth type of transmitter is that shown in Fig. 10, where B is a box, as before, with a mouthpiece, M, and an induction coil, D. The mouthpiece in this case is closed by a tympan connected at its center to a metal chain, or strip of chain mail, $c\,c'$, which is strained by the springs, $s\,s'$, and the tie, f. This chain is the current-regulator, and is traversed by the current. Between every two links there is a microphonic joint. The vibration of the tympan, on speaking in front of it, tightens or slackens the chain,



THE BAR TRANSMITTER.

thereby operating the current regulator and transmitting the sounds. The pressure between the links, which by preference are of iron, is regulated by adjusting screws.

Mr. Munro next read a "Supplementary Note on the Action of the Microphone." The original theory of Edison was that the internal resistance of carbon was reduced by pressure. Sir William Thomson supported the theory that the action is due to an increase or diminution in the area of surface-contact produced by increase or diminution of pressure. Mr. Preece considers that the microphone acts by heating at the points of contact when the current passes. It does not seem probable, however, that the variations of temperature can be so quick and sudden as the transmission of sonorous currents requires. Another reading of the theory may be that the heated points are of a spongy nature, and more sensitive to pressure; but here again it is difficult to see how the effect can be in simple ratio to the pressure. A fourth theory, supported by Professor Hughes and Professor Blyth, and probably first intimated by Mr. F. H. Varley, attributes the action of the microphone to a small arc formed between the points, and this appears to be a likelier hypothesis. The author, however, proposes a modification of it, and, instead of an "arc," in the ordinary sense, considers the cause a "silent" discharge through the film or stratum of air or liquid between the points, after the manner of a lightning guard—a silent discharge going on between numerous tiny projections on the carbon points, which in this respect resemble the corrugations or spines in two well known forms of plate-lightning arresters used in telegraphy. We have to figure to ourselves the microphone points covered with irregular projections which touch each other, but are bathed in the surrounding air and ether. These projections, like the points of a lightning arrester, are constantly discharging little jets of current from one to the other across the air between. But the action of the sound-waves is to move them to and from each other, thereby increasing and lessening the width of the air stratum, and varying the strength of the discharge.

The "boiling" or "buzzing" of a metal transmitter not properly adjusted reveals this "silent" discharge from a multitude of points. If the sonorous waves are too violent, the points are separated too far, the contact is broken, and a sharp click is heard in the telephone. This is due to the stoppage of the discharge. It is the sound heard on a larger scale on stopping the current in an arc lamp. It seems an effect of the rarefied arc rather than the heated points, for if it were due to the shrinking of the points it would be observable in an incandescent wire on stopping the current

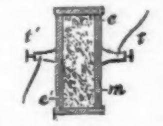


Fig 9,
THE GRAIN TRANSMITTER

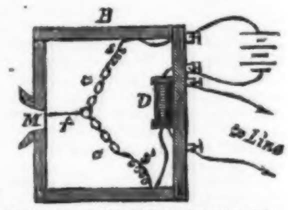


Fig. 10.—THE CHAIN TRANSMITTER.

through it. The author's opinion is that the rarefaction of the air and ether, caused by the discharge, is the true source of this effect. When the current suddenly ceases, the rarefied gas collapses, and equilibrium of fluid-pressure is restored. The application of heat, by the spirit flame, to two pieces of wire gauze in contact increases the microphonic action between them. When the flame is applied to the metal so as to heat the contact, tapping, as heard in the telephone, becomes louder, and gradually dies off when the flame is removed. Hot metals and flame are known to discharge electricity better than cold metals, and hence, in all probability, the slow discharge of the microphone is accelerated by this means.

The recent experiments of Mr. Shelford Bidwell appear to bear out the theory that the microphone acts mainly through the air discharge between the points. Thus he finds that the resistance of the contacts varies greatly with the strength of current when the pressure is small, and very slightly when it is great—that is to say, when the film of air is squeezed out. On reducing the pressure (with carbon at least), the resistance of the contact increases. Again, the resistance of the contact diminishes with increased current, an effect also noticed in the voltaic arc. Further, Mr. Bidwell finds that "when the strength of current exceeds a certain limit, the resistance is greatly and permanently increased; the greater the pressure, the higher will be such limit." This unexpected effect is difficult to explain on any theory but that of the "air discharge."

In the discussion which followed the reading of Mr. Munro's papers, Prof. Hughes said that he did not agree with Mr. Munro's theory of the air acting as a conductor, since very large currents pass through the microphonic contacts, showing that the resistance is much less than that of air.

Mr. Preece considered the whole action of microphones to be due to heat. This theory is borne out by the fact that microphones are reversible, *i. e.*, they can act as receivers. The fact that the best microphonic effects are produced with a low electromotive force is against the air-discharge theory.

Mr. Stroh referred to an experiment which he had made to determine whether any movement took place in a microphone when a current was passed through it; in this experiment the movements of the carbon piece were magnified by a ray of light in disk reflected from a mirror attached to the carbon; no movement could be perceived when undulations were sent from a carbon transmitter, but makes-and-breaks of contact were distinctly seen.

Prof. Ayrton considered that the microphonic effect was due to a change of electromotive force, and not of resistance, at the points of contact.

THE ACTION OF THE MICROPHONE.

By A. Stroh.

An experiment, which may help to throw light upon the action of the microphone was described by Mr. Stroh during a discussion on "The Theory of the Microphone" which followed the reading of Mr. Munro's paper as above at the Society of Telegraph Engineers and of Electricians. This experiment is as follows:

Fig. 1 represents a very small and delicate form of Prof. Hughes' so called hammer-and-anvil microphone.

On a thin board, A, is fixed a little block, B, which serves to hold four brass uprights, C C^1, and D D^1.

A light spindle, E, provided with a pivot or knife-edge at each end, rests on the uprights, C, and C^1. Attached to the spindle, E, on one side, is an exceedingly light concave reflector, F; while on the other side, and in good electrical contact with the spindle, is a thin rod of carbon, G. The latter rests at right angle, another rod of carbon, H, which is firmly fixed in the two brass uprights, D and D^1.

Terminals, I and I^1, communicate each with a pair of the brass uprights. A little spiral spring, the tension of which can be regulated by a small thumb-screw, serves to keep the two carbons in microphonic contact.

A loud-ticking watch, or other source of sound, is placed on the board, A.

The general arrangement of the experiment is shown in Fig. 2. M is the microphone just described. A lime-light, L, is placed behind a little screen with a small round hole in it, across which is stretched a fine wire, so that the image of the latter is thrown by the reflector of the microphone on a wall or screen at S, where a graduated scale may be fixed, and where, by means of the image of the fine wire, any deflection can be easily read.

A downward movement of the reflected spot of light

on the screen, S, indicates a separation of the carbons at the point of contact, while an upward movement would be due to an approach of the carbons toward each other.

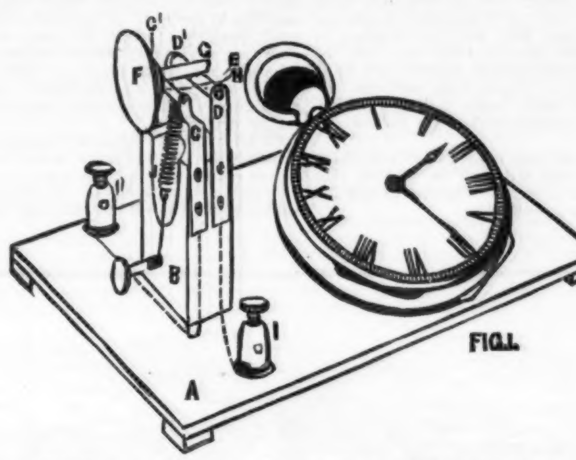
A telephone, T, a make-and-break key, K, a battery, B, and the microphone, M, are joined in circuit. The adjustment of the latter is now made so that the ticking of the watch is heard as loud as possible in the telephone, T, while the observer has one hand on the key, K, and is also watching the spot of light at S.

At the instant when the current is broken at K, the spot of light moves upward, not sluggishly, but suddenly and sharply, the sound in the telephone of course ceasing at the same moment.

On making contact again the spot of light quite as suddenly returns to its former position, while the ticking is heard again.

The distance through which the spot of light moves is very small, but the action is so decided and unfailing that there is no difficulty in observing it.

It happens sometimes that microphones are uncertain in their action, and will suddenly fail to work, and in observing the spot of light during some such failures it was found that it jumped upward at the same moment when the telephone became silent, and returned as soon as the microphone was brought into action again by a tap on the table. It was *only* during the clear working of the telephone that the spot of light remained steadily deflected downward, which seems to indicate that during the time when the carbons are really in what is called microphonic contact they are not in contact at all, or at all events, that there is a repellent action at the point of contact.



THE ACTION OF THE MICROPHONE.

FIG.2.

With a single element of a small bichromate battery in the circuit, the deflection was hardly perceptible; but with three elements the spot of light moved through one millimeter between making and breaking.

When a greater number of elements was used, the deflection was also greater, but there was much hissing, and the spot of light was not steady.

With three elements the experiment succeeded best; with this number the ticking of the watch could be heard loudly and clearly without any hissing.

In order to arrive at an estimate of the distance which appeared to exist between the two carbons at the point of contact during their action as a microphone, it may be mentioned that the distance between the screen, S, and the reflector was six meters, and that between the fulcrum and point of contact of the microphone six millimeters, so that the former distance was 1,000 times greater than the length of lever in the microphone. This figure has to be doubled on account of a reflected beam of light moving through double the angle of the reflector itself.

The total deflection on the screen, S, being one millimeter, the distance to which the upper carbon was repelled during microphonic action, under the circumstances described, was therefore $\frac{1}{2000}$th part of a millimeter.

ELECTRIC STREET PASSENGER CAR.

AT the invitation of the Electrical Storage Company, Limited, a large number of scientific gentlemen lately assembled at Gunnersbury to assist at the inauguration of an electrically propelled car upon the lines of the West Middlesex Tramway Company. This car, which we illustrate above (see also engraving in SUPPLEMENT 382), was in outward appearance of the ordinary kind, except that it was not provided with any appliance for the attachment of horses. Its motive power was derived from fifty Faure-Sellon-Volckmar secondary battery cells or accumulators, carried beneath the seats, and a Siemens dynamo machine (type D,). As will be seen from Fig. 2, the dynamo, A, carries a grooved pulley at the end of its spindle, and from this a belt, provided with V shaped wooden blocks upon its inner side, conveys the motion to a suitable pulley on a countershaft, D. A second belt and a pair of pulleys, the larger of which is on one of the car axles, serve to rotate the driving wheels, the four pulleys being so proportioned that the normal speed of the car is from six to eight miles per hour. The stopping is effected by interrupting the current, and applying a brake of the usual construction. Variations of speed are attained by means of a switch which brings more or fewer of the cells into the working circuit, while the car is reversed by a simple and ingenious arrangement of the brushes of the dynamo machine, devised by Messrs. Siemens Brothers. There are two pairs of brushes, one for the backward and one for the forward motion, and these are arranged on two rocking levers, there being one brush of each pair on each lever. When the levers are vertical, both sets of brushes are clear of the commutator, but when they are inclined, by means of a spring handle, to the right, say, the upper brush of the left lever and the lower brush of the right lever come into contact with the commutator, and the car goes ahead; when inclined to the left, the upper brush of the right lever and the lower brush of the left come into operation, and the car goes backward, the diameter of commutation having been angularly displaced 70° or 80°.

The fifty accumulators weigh 1·78 tons and occupy 29 cubic feet of space in all, their individual size being 13 inches by 11 inches by 7 inches, and their weight 80 lb. Their combined storage capacity is 560 ampere hours, with an electromotive force of 107 volts. Of this charge it is stated that 70 per cent. may be withdrawn with economy. The dynamo machine is designed to work with an electromotive force of 100 volts, and a current of 60 amperes, equal to 6,000 volt-amperes, or 8 electrical horse-power.

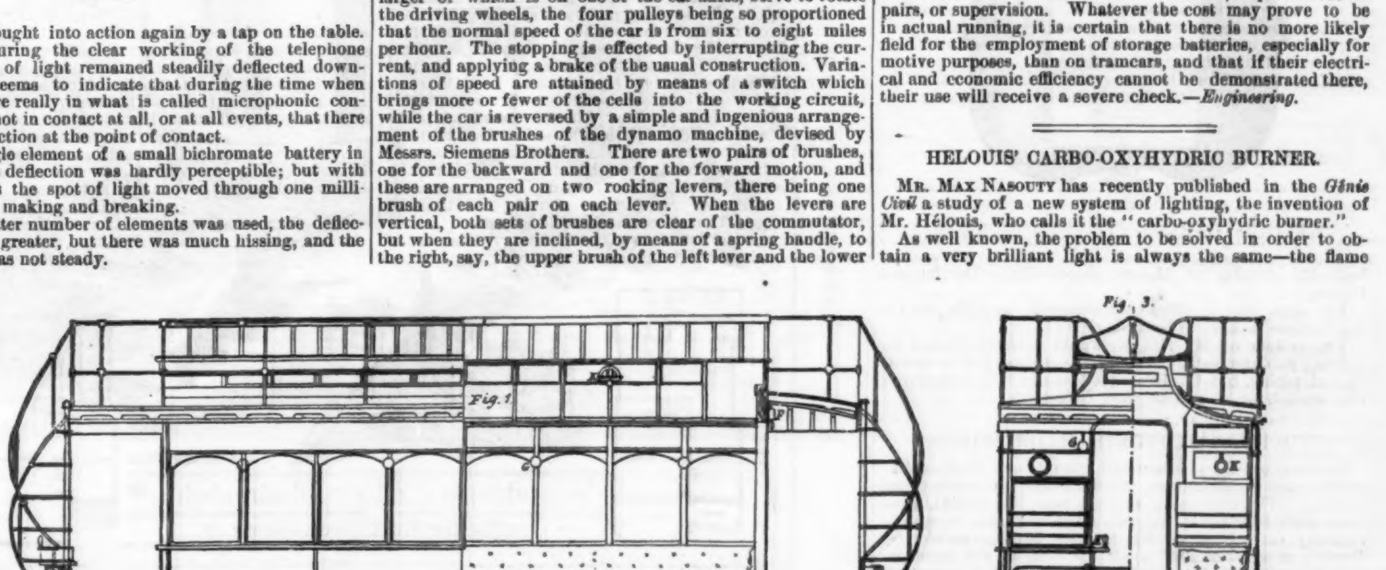
The car was placed in the hands of General Hutchinson, in order that he might report to the Board of Trade as to whether it could be used on public roads with safety to the general traffic. He made several runs with it upon the Acton road, where it attained a maximum speed of about six miles an hour, and was found to be under perfect control. Before the experiments were completed a hitch occurred in the mechanical arrangements, and the car had to be drawn to Kew and repaired before the visitors could make a trip upon it. After an interval, during which the launch Electricity, which we illustrated on page 329 of vol. xxxiv., was engaged in taking the visitors short circular voyages above Kew Bridge, the car was said to be ready and was immediately filled. It was first drawn by four horses up the slight incline from Kew to Gunnersbury, and then left to its own unaided power, under which it progressed steadily at a rate of about five miles an hour to the first crossing-place, a distance of half a mile or so, the line being slightly down grade. When the ordinary car, for which the stoppage was made, had passed, it was again attempted to start, but without avail, and after considerable delay the four horses were brought up, and the remainder of the journey to Uxbridge road was performed by their aid, to the amazement of the inhabitants of Turnham Green. To the unscientific onlooker the scene must have recalled an incident in Mr. Burnand's comic "Ride to Khiva," where the hero, after stimulating his horse by electricity for many hours, found on stopping that he had been stone dead for the last twenty miles, and had been merely kept going by the energy of the current passing through him.

It is to be regretted that electric traction should have been made so ridiculous, and it is the more annoying when it is remembered that the failure was due, not to the electrical, but to the mechanical arrangements of the car. It is a matter wonder, after fifty years' experience of locomotives and road carriages, that transmission by straps should have been adopted, especially between the countershaft and the driving axle, where the speed is necessarily very small, and the strain, particularly in starting the car, exceedingly heavy. We shall be glad to give the results of the next experiment, which, we trust, will be more successful, as there is no reason whatever why a car should not be propelled by storage batteries. The question of the practical adoption of this system of haulage turns entirely upon its cost as compared with horse flesh, and all the tramway companies will await with interest to learn the result of a continuous trial under the conditions of every-day practice. Mr. Sellon states the minimum cost per tram car-day to be 6s. 3d. as against 26s. for horse haulage, but his estimate assumes that there will be developed in the car 50 per cent. of the indicated horse-power of the engine at the central station, and further takes no account of interest, depreciation, repairs, or supervision. Whatever the cost may prove to be in actual running, it is certain that there is no more likely field for the employment of storage batteries, especially for motive purposes, than on tramcars, and that if their electrical and economic efficiency cannot be demonstrated there, their use will receive a severe check.—*Engineering.*

HELOUIS' CARBO-OXYHYDRIC BURNER.

MR. MAX NASOUTY has recently published in the *Génie Civil* a study of a new system of lighting, the invention of Mr. Hélouis, who calls it the "carbo-oxyhydric burner."

As well known, the problem to be solved in order to obtain a very brilliant light is always the same—the flame



NEW ELECTRICAL STREET PASSENGER CAR.

must contain some body or other, carbon or refractory material, brought to incandescence.

Mr. Hélouis has endeavored to solve the problem by combining the carbureting of ordinary illuminating gas with the incandescence of lime.

The method consists, on the one hand, in carrying a crayon of lime to incandescence through the action of a jet of oxygen, and, on the other, in employing this oxygen in the combustion of a jet of ordinary gas very strongly carbureted by the vapors of solid or liquid naphthaline.

Referring to the accompanying cut, the reservoir of naphthaline is shown at R. The gas enters through H¹, and flows through H to the vaporizer. Besides, under the influence of the gas's pressure, the liquid rises into the vaporizer through the plunge tube, *a*. The extremity, *b*, of this latter is provided with a nozzle which, jointly with a cock, regulates the flow of the hydrocarburet into the chamber, B. This chamber is highly heated by the crayon of refractory material, which is in a state of incandescence above it.

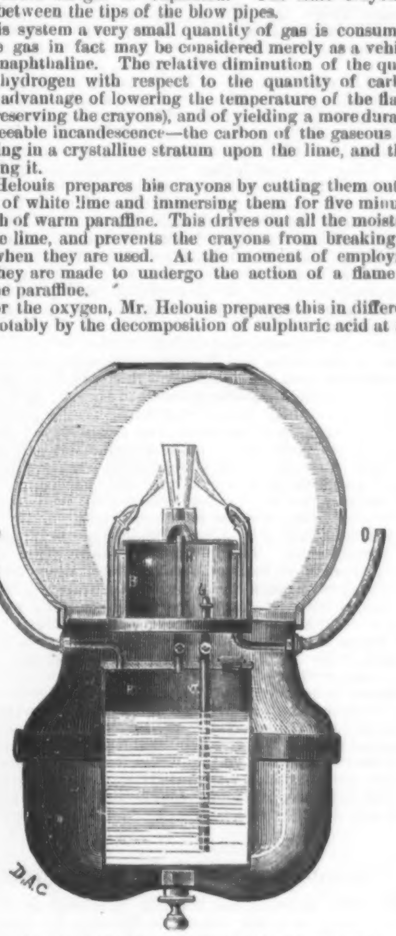
The vapor of naphthaline, mixed with illuminating gas, escapes through the upper apertures, *m*, which communicate with four oxygen blow pipes supplied by the tube, O.

The combustion of the carbureted gas, under the action of the hydrogen, is effected only on issuing from the blow pipes, *without previous mixture* and consequently without any possible danger of explosion. The lime crayon is placed between the tips of the blow pipes.

In this system a very small quantity of gas is consumed, and the gas in fact may be considered merely as a vehicle for the naphthaline. The relative diminution of the quantity of hydrogen with respect to the quantity of carbon has the advantage of lowering the temperature of the flame (thus preserving the crayons), and of yielding a more durable and agreeable incandescence—the carbon of the gaseous jet depositing in a crystalline stratum upon the lime, and thus protecting it.

Mr. Helouis prepares his crayons by cutting them out of a block of white lime and immersing them for five minutes in a bath of warm paraffine. This drives out all the moisture from the lime, and prevents the crayons from breaking in pieces when they are used. At the moment of employing them, they are made to undergo the action of a flame to expel the paraffine.

As for the oxygen, Mr. Helouis prepares this in different ways, notably by the decomposition of sulphuric acid at red



HELOUIS' CARBO-OXYHYDRIC BURNER.

heat—the process of Messrs. Sainte Claire Deville and Debray

The apparatus is differently arranged, according to the applications that are to be made of it.

The system of Mr. Helouis would scarcely answer for lighting public streets, owing to the necessity of a double line of piping, but it gives excellent results in manufactories, workshops, etc.—*Chronique Industrielle.*

WOODMAN'S COTTAGE, MADRESFIELD.

MATERIALS: Local bricks and stone, black Staffordshire plinths and string-courses, Staffordshire tile roofing and cresting. The cottage is situated near Woodsfield, about three miles from Great Malvern. The work has been satisfactorily carried out by Mr. Charles Bishop, builder, of Powick, at a cost of £331, from the designs and under the superintendence of Messrs. Ernest W. Farebrother, A.R.I.B.A., and P. A. Robertson, architects, Grimsby.—*Building News.*

[GLASSWARE REPORTER.]

GENERAL CHARACTERISTICS OF CLAYS.

THE constituent parts of all clays, properly so called, are alumina and silica. All other ingredients, except water (and there are many), are extraneous to its composition.

The proportions of these two ingredients to each other are variable; sometimes the alumina exceeds, but most commonly the silicious ingredient predominates. When the alumina exceeds, its proportion to silex scarcely ever reaches, but sometimes approaches, the ratio of 4 to 1; but more frequently subsists in the ratio of 3 to 1, or 2 to 1, or 1·5 to 1, or approaching still nearer to equality. When the silicious element exceeds, which is by far the commonest case, it is found at most, and very rarely, in the proportion of 6 to 1, more commonly in that of 4 to 1; and still oftener in that of 3 to 1, or 2 to 1; more rarely it approaches an equality.

The proportions produce different effects. Thus the clay in which the silicious ingredient enters in the proportion of from 3 or 4 to 1 are best for porcelain; those in which the alumina exceeds are best for coarse pottery, and particularly for glass house pots, as being proof against the action of alkalies.

The kind of silicious stone which forms the sandy part of clay is more frequently quartz, but it also may be hornstone or feldspar, or of various other species which will much influence the internal properties of the clay. The nature of the sand can be tried, after separating it as much as possible by washing. If the sand be of the quartz kind, it is best separated by boiling the whole in oil of vitriol, which will take up the alumina and leave the quartz; but if it be a comminuted feldspar, or other compound stone, this stone itself will be decomposed by that acid; so that the trial should rather be made on the part separated by washing.

The colors that occur in clays are very numerous, and depend on metallic, or vegetable, or bituminous, or coaly particles pure clay being always white. The colors arising from the particles of a vegetable, coaly, or bituminous nature are destroyed by heat in an open fire, and are therefore in no way prejudicial to the finer uses to which clay may be applied; but those arising from metallic particles are most obstinate. Sometimes, however, the metallic particles are engaged only in the coarser sandy parts, and may with it be separated by elutriation; sometimes they are picked out by the hand.

With respect to fusibility, we may remark that clays which contain only alumina and silica will melt in no heat that can be produced by our furnaces, in whatever proportion these two ingredients may be to each other.

But calcareous earth, in the proportion of 10 or 12 per cent, will render any clay fusible. Calxes of iron, if united to the alumina, will render the clay fusible; if united to the silicious part, and if this part considerably predominates, the clay will not be fusible.

It would seem, therefore, that an addition of pure silica to any clay in such proportion as not to destroy its ductility would not render it fusible; the addition of lime, or calxes of iron, would, on the contrary, render any clay fusible.

As the infiltration of water frequently conveys calcareous earth and calxes of iron, and as beds of coal obstruct this infiltration, hence the clays found under coal are generally the most fusible.

Clays owe their plasticity entirely to the aluminous ingredient which they contain.

Colored clays of the common or coarser kinds were found by Mr. Morveau to contain some contamination of the vitriolic or sulphuric acid, but in white clay he could discover none.

This acid is probably united to the ferruginous particles that are found in those clays, and to which they owe their color and fusibility. The yellow, however, sometimes derive their color from regulus of antimony, bismuth, lead, silver, or zinc.

Blue clays and marls sometimes whiten when heated, and consequently owe their color to volatile matter, coal, or bitumen, but some redden, and contain pyrites. Neither Beame nor Woulfe, in the course of their exhaustive analysis of clays, could find sulphuric acid in some blue clays, but the pyritic test, the nicest of all, was not known when their experiments were made.

Bergman found copper and cobalt in some blue clays; from others Rinman extracted 13 per cent. of iron, and 4 of lead, besides some traces of zinc.

Black clays are sometimes bituminous, sometimes pyritic.

Dr. Watson mentions a singular clay (or rather earth, since it contains no sand) which burns to a white brick. It contains 25 per cent. of aerated calx, 2·2 selenite, with a small quantity of oxide of iron, the remainder alumina. However, as this clay was not treated with sulphuric or any mineral acids, which alone can separate the aluminous from the silicious parts, it is probable it still contained sand of great fineness. The selenite also probably was formed during the drying.

Of brick clay the colors are various—reddish, bluish, brown or yellowish; the best is that which, when burned, has the fewest cracks, and this depends on the proportion of the sand it contains. If it contains too much, the clay will not be sufficiently ductile; if too little, the bricks will be rifty, and in that case more fine sand should be added. Therefore, potter's clay, if sufficiently sandy, will serve; the best proportion is 0·86 silex to 0·14 of alumina. Aluminous marls are also very proper, but they should be well burned to vitrify the calcareous parts; calcareous marls vitrify too easily, and therefore require an addition of clay. The coarse, martial clays, that contain scarcely any calcareous particles, are best; when slightly burned they are reddish, when more, they become yellow, or browner. Salt thrown into the kiln at its greatest heat will vitrify the surfaces of the bricks and prevent them absorbing water.

This clay often contains selenite, which is decomposed by the common salt contained in mortar, and hence the Glauber salt found efflorescing on bricks. This is also decomposed by the joint action of fixed air and lime, and hence the efflorescence of mineral alkali.

Volatile alkali has often been found in clays, particularly in those that contain iron, a circumstance that long puzzled mineralogical writers. Dr. Austin has shown, by well contrived experiments, that when inflammable air, in its nascent state, slowly and gradually meets carbonic acid gas, they combine and form volatile alkali. Now iron in its metallic state, sojourning with water, always extricates inflammable air, which, meeting with the carbonic acid gas of the common atmosphere, thus forms volatile alkali.

ABOUT STONEWARE.

THIS is a grade of ceramic ware of more than ordinary hardness and value.

The stoneware of London is made of pipe clay from Dorsetshire and Devonshire, calcined and ground flint from Staffordshire, and sand from Woolwich and Charlton. The dry clay is pulverized and sifted. The ingredients are compounded in different proportions, according to the fineness of the ware, its size, and purpose. The round articles are turned on a wheel, dried, and shaved in a lathe. Articles of other shapes are moulded. The articles are then stacked in the kiln, with pieces of well-sanded clay placed between them to prevent their adhering. A slow fire dissipates the moisture, and the heat is then raised until the flame and ware have the same color.

The glaze is then added by pouring 20 or 30 ladlefuls of common salt into the top of the kiln. This is volatilized by heat, becomes attached to the surface of the ware, and is decomposed, the muriatic acid flying off and leaving the soda behind it to form a fine, thin glaze on the ware, which resists ordinary acids.

The labors of Wedgwood date from about 1762, and the art attained great exellence under his fostering care, ingenuity, and taste. Aiken says:

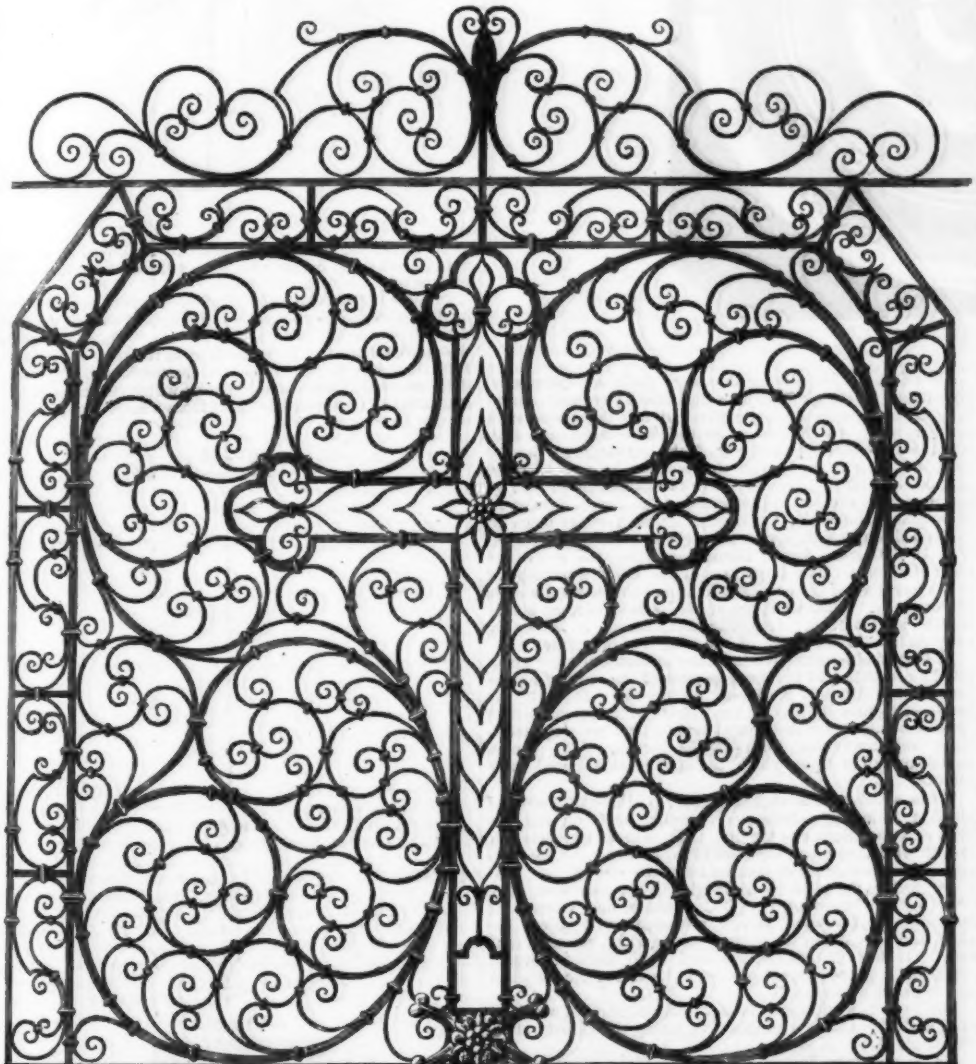
"With a liberal ambition far above the love of gain, his ruling object was to carry the art that he practiced to the uttermost perfection of which it was capable. For this he spared neither time, nor labor, nor experience: and his splendid success, inciting others to follow in the same track, has secured to his country a most important branch of internal and foreign commerce, and has placed his name forever among the worthies of the British nation.

"He perceived that the defects of the Delft-ware, at that time the only species of pottery employed for common domestic purposes, were the softness and looseness of texture of its body, which obliged the potter to make it thick and clumsy and heavy, in order to secure to it a moderate durability; and that its porousness, as well as its dirty gray color, required a thick coating of white enamel, which added still further to its bulk and weight, and which, containing a large proportion both of lead and arsenic, was hardly safe for culinary use. He began, therefore, by inventing a body for earthenware which at the same time should be white and capable of enduring a very high degree of heat without fusion, well knowing that the hardness of the ware depended upon the high firing to which it had been subjected. For this purpose, rejecting the common clays of his neighborhood, he sent as far as Dorsetshire and Devonshire for the whiter and purer pipe clays of those countries. For the silicious ingredient of his composition he made choice of chalk-flints calcined and ground to powder.

"It might be supposed that white sand would have answered his purpose equally well and have been cheaper; but being determined to give the body of his ware as great a degree of compactness as possible, it was necessary that the materials should be reduced to the state almost of an impalpable powder; and calcined flints are much more easily brought to this state by grinding than sand would be. The perfect and equable mixture of these two ingredients being a point of great importance, he did not choose to trust merely to the ordinary mode of treading them together when moist; but having ground them between stones separately with water to the consistence of cream, he mixed them together in this state by measure, and then evaporating the superfluous water by boiling in large cisterns, he obtained a composition of the most perfect uniformity in every part. By the combination of these and other ingredients in different proportions, and exposure to different degrees of heat, he obtained all the variety of texture required, from the bibulous ware employed for glazed articles, such as common plates and dishes, to the compact ware not requiring glazing, of which he made mortars and other similar articles.

"The almost infusible nature of the body allowed him also to employ a thinner and less fusible glaze, that is, one in which no more lead entered than in common flint glass, and therefore incapable of being affected by any articles of food contained or prepared in such vessels. With these materials either in their natural white or variously colored—black by manganese, blue by cobalt, brown and buff by iron—he produced imitations of the Etruscan vases and of various other works of ancient art, such as the world had never seen, such as no subsequent artist had ever attempted to rival.

"In this table ware for many years he led the way almost without a rival; but the immense demands occasioned by the successive improvements of this article, which first put down the use of Delft, and then of pewter, gave ample room to men of capital and skill to enter the field of profit and competition. Much good has hence resulted; many subordinate improvements have been effected and are almost daily making; but it is to be regretted that many of the most modern ones have reference rather to cheapening the price than improving the quality of the ware or even keeping it up to the original standard."—*Glassware Reporter.*



SUGGESTIONS IN DECORATIVE ART.—WROUGHT IRON RAILING BY FABBRONI, MILANO.—*The Workshop.*

CARBON TRANSPARENCIES FOR THE LANTERN.

THE first essential in a successful lantern transparency is a suitable negative, and photographers about to adopt this, the best of all processes for the purpose, must begin at the beginning and produce their negative first of all.

For silver printing and, in fact, for any class of prints to be viewed by reflected light, it is necessary that the negative be sufficiently dense to allow the darker parts of the print to gain a certain depth before the lights are printed through, in order to give vigor and brilliancy. For a lantern transparency, however, the darker parts do not require such a body of color, but only so much as to still allow the light to give the detail existing in the shadows as in the lights. This being so, in taking negatives for lantern transparencies, care must be taken not to have them too dense, but only so much so as to give proper gradations between high lights and deep shadows; at the same time they must be fully exposed and not flat.

What a field of delight the production of negatives for this purpose offers, and with what little exertion it can be done! A quarter plate pocket camera and two single landscape lenses (one of long focus and one short), half a dozen double backs, and a light Alpenstock stand are all that will be required in the way of apparatus. Use the best plates you are acquainted with, and develop them with the sulpho-pyrogallol developer.

The negatives being taken, the next step is to prepare them for printing. This is effected by pasting on the reverse side of the negative a square mask, with an opening a little larger than the finished slide is intended to be, which forms the safe edge so essential in carbon printing, and especially so when the carbon print has to be developed upon glass.

The best carbon tissue in the market for this purpose is the Autotype Company's "portrait brown," No. 113. which can be had in half bands ready sensitized; and, as it will keep good for a month, if kept in an air-tight tin case, it is strongly recommended that it should be so procured, as then not only is the operation of sensitizing avoided, but also that of drying, to which operation considerably more than half the failures that are met with in carbon printing are traceable.

To those photographers, however, who prefer to sensitize their own tissue, the following method will be found the best of any the writer has as yet tried:

Cut the tissue in rolls of about four feet long and seven inches wide. Make a solution of bichromate of potash one and one-half ounce, water forty ounces. and liquor ammonia half a drachm; filter carefully and pour into a deep dish about eight inches long and as narrow as possible (say a small brown pie dish). Now immerse one of the rolls of tissue, and unroll it the reverse way, keeping it under the solution as much as possible; when rerolled take hold of the end and lift it slowly out of the solution and hang it over a line or a rod (face outward) to dry. Tissue so sensitized will dry in half the time, keep longer, and be more manageable than if sensitized by soaking the usual time. Where it is possible to get the use of a kitchen *not* lit by gas, tissue so sensitized will dry in four or five hours.

The next operation is the exposure under the negative, which must be timed by means of the actinometer. For the class of negative recommended, two tints will be found ample. The exposure being effected, the carbon prints are developed upon good glass previously polished, and coated with gelatine one-quarter of an ounce, bichromate of potash thirty grains, water ten ounces. This is applied warm (after careful filtering), and when the plate is dry it is exposed to day or sun light for a few hours so as to render the coating of gelatine quite insoluble. Upon this substratum the exposed carbon print is squeegeed down, and subsequently developed in hot water.

Carbon transparencies so made will be entirely dependent for their quality or suitability for the lantern upon the character of the negative as to density or thinness (not flatness). If the negative be dense so will the carbon transparency, and *vice versa;* but it will soon be apparent to the operator which is the best class of negative after making a few transparencies from negatives of different grades of density and projecting the same upon the screen.—*W. T. Wilkinson, in Br. Jour. of Photo.*

HOW I DEVELOP GELATINE EMULSION NEGATIVES.

By Prof. HENRY J. NEWTON.

Stock Solution No. 1.

Carbonate of soda	500 grains.
Water	10 ounces.

Stock Solution No. 2.

Pyrogallic acid	20 grains.
Oxalic acid	30 "
Bromide of ammonia	10 "
Water	10 ounces.

To use, take equal parts of each, thoroughly mixed, and flow over the exposed plate after it has been laid in water for a minute or two.

This is a simple formula and contains all the fundamental elements for successful working, but it is capable of a great variety of modifications which would doubtless better adapt it to special or peculiar work.

The bromide is not necessary except in case of overexposure; or, in other words, leave out the bromide and you get equally good negatives with about one-half the exposure. I always have two stock bottles, one with the bromide and one without. My work is mostly out of doors, and I generally expose half a dozen plates before developing. To the first one I use equal parts from the two pyro bottles—the one with and the other without the bromide. I therefore have in two ounces of developer one fourth of a grain of bromide. The result determines whether *more* or *any* bromide shall be used in developing the remaining plates. When, by error in judging of the actinic force of the light on a particular day, it becomes evident that the plates have been underexposed, I then dispense with the bromide and use a much stronger solution of soda, ranging from 80 to 100 grains to the ounce. On the other hand, if, from the same cause, it is apparent that the plates have been overexposed, a weaker soda solution is used—say 5 to 10 grains to the ounce, with the addition of 3 or 4 grains of bromide.

It will be apparent that with this developer you can succeed in making a good negative and yet have great latitude in the time of exposure. I have experimented with a great variety of acids other than the oxalic, and find they possess some influence on the color of the negative. Glacial phosphoric acid, one and one-half grains to the ounce of water, or concentrated formic acid, two drachms to one quart of water, give equally satisfactory results, and, I think, better colored negatives than oxalic acid. But these acids are not always to be had, even in large cities, whereas oxalic acid is easily obtained in any country town.—*Photographic Times.*

APPLICATION OF SULPHOCYANIDE COMPOUNDS IN CALICO PRINTING.

ON printing alizarine red on calico by means of acetate of alumina the metal of the rollers is attacked by the acid, and salts are thus formed which interfere with the pure shades of the color. By using sulphocyanide compounds it is possible to work without acetic acid. It has been found by Storck and Laube that a neutral mixture of alizarine acetate of lime and aluminum sulphocyanide develops the red very well on steaming, and fixes it very completely. The authors claim for their process that no iron gets into the color; that the color can only be developed on steaming, and therefore forms more slowly, and is better fixed; further, that the print is clearer and the process cheaper, as no acetic acid is used, and the shade is a quarter more intense. Aluminum sulphocyanide is prepared by mixing three kilos commercial aluminum sulphate, five liters of water, and 4·08 kilos barium sulphocyanide. The filtered solution stands 19° B.

ASTIGMATISM AND OPHTHALMOMETRY.*

In my last lesson, I spoke to you about *astigmatism*, that anomaly in the refraction of the eye which consists in a difference in the refracting power of its meridians. Such inequality of refraction is caused by an asymmetry of the curve of the cornea (*corneal astigmatism*), which is the most frequent occurrence, or the crystalline lens (*astigmatism of the crystalline*), or of both organs at once. The two meridians of the eye that exhibit the greatest difference in refraction are called principal meridians; and they are preceptibly perpendicular to each other. Astigmatism is said to be regular when the refraction varies, from one meridian to the other, according to a law such that the eye may be likened to an ellipsoid with three unequal axes. Irregular astigmatism may be connected with: (1) an irregular variation in refraction in the same meridian; (2) a different degree of astigmatism on parallels more or less near the summit; (3) a different direction of ametropia in the different parellels; and (4) still more complicated imperfections in form. Regular astigmatism is capable of correction; and it is the only one that we have to occupy ourselves with at present.

FIG. 1.

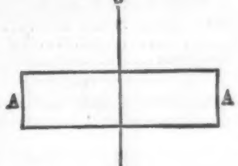


FIG. 2.

The astigmatic eye never sees a luminous point as a point, but as a luminous line or as a circular or elliptical luminous spot. Clearness of vision suffers from it, and its sharpness is often diminished, especially when the pupil enlarges as a consequence of insufficient light. Astigmatic persons then consult a physician, who makes a diagnosis and prescribes suitable correcting glasses.

It remains for me now to show you the methods that may be used to determine the astigmatism of the living eye. You are all acquainted with that examination of astigmatic persons by the aid of spherical and cylindrical glasses which is performed by taking for an object a sheet of cardboard whereon are traced black lines in the shape of a star. With this method it is necessary to find a cylindrical glass, or a combination of a spherical and cylindrical glass, which shall give upon the retina of the astigmatic person a clear image of all the rays of the star at once. In order to obtain a constant result, it is often necessary to have recourse to atropine so as to suppress the influence of accommodation on the form of the crystalline. There may be determined in this way the total astigmatism that the eye exhibits without accommodation.

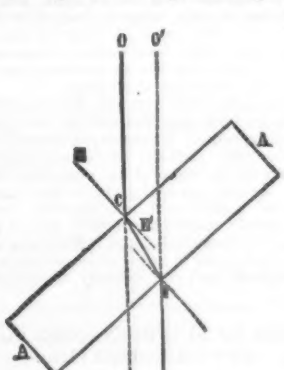


FIG. 3.

Aside from the inconveniences of atropine for the patient, this method is subjective; in other words, it depends upon the responses of the patient, and these, often uncertain or contradictory, may lead the physician into error and cause a great loss of time.

After determining the total astigmatism of the eye by this method, we never know what part of it is due to the cornea and what part to the crystalline lens. We cannot say how far the corneal astigmatism is increased or diminished by that of the crystalline.

An effort has for a long time been made to devise some instrument by the aid of which the radii of corneal curvature might be measured directly. Before describing such an instrument, which is called an *Ophthalmometer*, and with which may be studied the form of the *refractive surfaces of the eyes*, I wish to say to you that we can, by a very simple method, find out whether the cornea is astigmatic or not, by making use of the vertical images that the cornea furnishes. If we place before the astigmatic cornea a white piece of cardboard on which are drawn black concentric circles (Fig. 1), the latter depict themselves upon the eye in the form of ellipses. The large axes of the ellipses correspond to the meridian of the cornea which has the greatest radius of curvature. Such a change of circles into ellipses shows regular astigmatism. Irregular astigmatism is shown by irregularities in the edges of the images of the circle.

The ophthalmometer renders the examination more accurate by permitting of the measurement of the radii of curvature of the different meridians of the eye. It is to the genius of Helmholtz that we are indebted for the completest ophthalmometer, an instrument with which we may determine objectively the form of the cornea. The fundamental principle upon which the apparatus is based is as follows:

When we observe an object, O (Fig. 2), through a strip of glass, A A, having plane and parallel surfaces, and the glass is perpendicular to the line, O B, which connects our eye, B, with the object, O, there is no influence on the passage of the luminous ray coming from the object, O. But, if we incline the glass so as to give it the direction, A A (Fig. 3), the luminous ray, O C, deviates, and instead of directing itself toward D, it is refracted as it enters the glass, and approaches the perpendicular, E E^1, raised at that point. It then directs itself toward F, to there undergo a deviation in an opposite direction on its exit from the glass and to proceed toward D^1.

The ray, then, deviates in a direction parallel with its first, and the observer, instead of seeing the object at O, will see it removed to O^1.

Let us now take, instead of a single piece of glass, two pieces with plane parallel surfaces contiguous by their wider sides, as shown in Fig. 4, where the two pieces, seen from above, are turned in opposite directions.

If we look at the object, O, through these two pieces of glass, and if the line of separation of the two and the horizontal diameter of our pupil are situated in the same horizontal plane, we will see through the two pieces at once, and, instead of a single image of O, we will have two, at D and D^1, that we will project at O and O^1. We will see the object double.

Helmholtz's ophthalmometer (Fig. 5) consists of a spyglass, in front of which are placed vertically, one above the other, two plates of glass, movable in opposite directions around a vertical axis. The upper plate corresponds to the upper half and the lower one to the lower half of the objective. When the two plates are in the same plane, only a single image of the object is seen; but, if the plates are turned in opposite directions, the rays emanating from the object and passing through the upper plate are deflected to one side, and those which pass through the lower one are deflected to the other. A system of wheels and pinions permits of turning the plates symmetrically in an opposite direction, so that the two shall be equally inclined on the axis of the instrument, BC. The value of the angle of inclination, 0, is given in degrees by a graduated circle fixed on the instrument. If we look at a horizontal line, AA, through the ophthalmometer, we shall see, on turning the plates, a complete doubling of the object. The amount of separation of the double image may be deduced from the value of the angle formed by the plates and the axis of the spy-glass.

When it is desired to measure the curves of the different

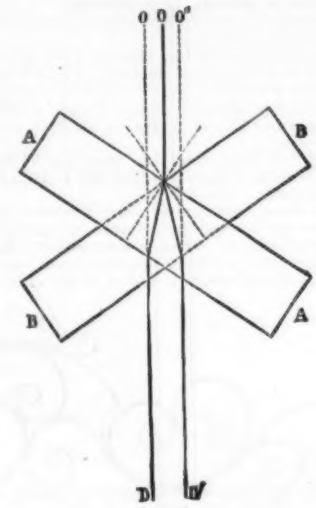


FIG. 4.

meridians of the living eye, there are employed as a luminous object small flames, which are reflected from the curved surface of the cornea.

In these experiments, the head of the person to be examined is fixed in such a way that the optical axis of the eye is situated in the axis of the instrument. There is fixed on the ophthalmometer, perpendicular to its axis, a graduated rule that may be turned in all the meridians, and on this there are placed three small mirrors which reflect on the eye that is being observed the light from a large lamp located

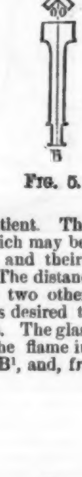


FIG. 5.

over the head of the patient. The images of the flames in these three mirrors (which may be moved along the rule) are reflected by the cornea, and their images observed through the ophthalmometer. The distance from the mirror, B, to the middle, B^1, of the two others (Fig. 6) is taken as the object whose image it is desired to double on the cornea by turning the glass plates. The glass plates are revolved until the second image of the flame in the mirror, B, coincides with the first image of B^1, and, from the angle of rotation that it has been necessary to give the plates, there is deduced by calculation the size of the corneal image of the distance, BB^1, and the radius of the cornea's curve in the meridian observed. To employ this instrument, it is necessary to operate in the dark, to use a light arranged in a special manner, to arrange fixed tables in the parquet, and to calculate the data afforded by the observation. If it be desired to examine the astigmatism of the ellipsoidal surface (of three unequal axes) that the cornea of our eye exhibits, it is necessary to measure successively, from 15 to 15 degrees, the radius of the curve of the meridians of the cornea. Each of

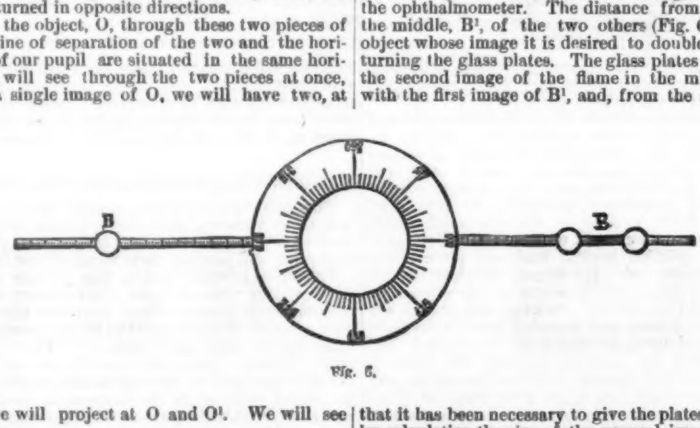


Fig. 6.

* Lecture by M. Gavarret, delivered at the Faculté de Médecine, Paris.

such mensurations requires eight readings of the instrument and long calculations. The examination of a single eye is often too much for the strength of the patient, and takes more time than the physician can give to each person. On account of such difficulties, this instrument has remained a valuable laboratory apparatus; but, in the hands of its illustrious inventor, it rendered immense services to science.

Our *confrère*, Dr. Javal, after becoming convinced of the difficulties attending the managing of this classic apparatus, undertook the task of modifying it so as to render it practical; and at the Ophthalmological Congress at Milan in 1862, presented the modification which you see here. The lower

FIG. 7.

plate is stationary, and the upper one may be revolved by a lever which indicates at the same time, on a graduated arc, the refractive power of the meridian measured. By revolving around its axis the instrument on which are fixed the gas flames, there are at once found the two meridians of greater and less curvature. As a reading on each of these meridians gives its refraction, we immediately obtain through the difference the corneal astigmatism expressed in dioptrics. This instrument marked a great progress as regards rapidity of determination, but was not yet freed from the difficulties attending artificial illumination, or from the cause of error residing in the defects of the observer's eye. I shall not dwell any longer on this instrument, which has played so important a part in the history of modern ophthalmometry, but shall hasten to direct your attention to the last victory that Dr. Javal, in conjunction with Dr.

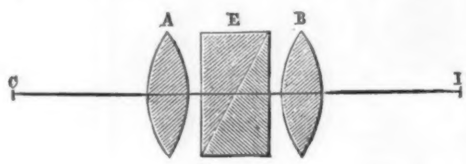


FIG. 8.

Schiötz, of Norway, has gained. Thanks to his indefatigable researches, he has found a practical method of determining in dioptrics, and without calculation, and in operating in broad daylight, the corneal astigmatism in patients of the clinical service.

This new ophthalmometer of Drs. Javal and Schiötz is based on the following principle:

Place vertically before your eyes a small square of white cardboard, having in its center an aperture into which is set a lens of 10 to 20 centimeters focus. Look through the center of the lens at another eye which itself fixes the center of the lens. You will see in such eye an image of the square. This image reflected by the cornea is so much the

Fig. 9.

smaller in proportion as the observed cornea is more convex. Suppose that the observed cornea be astigmatic, and that the vertical meridian of the cornea be more convex than the horizontal; then the image will no longer have the form of a square, but will have that of a rectangle. The vertical sides of the image will be smaller than the horizontal sides.

In order that the corneal image shall exhibit sharp and well-defined contours, it is necessary to place the square perpendicular to the line of fixation of the two eyes. This line is the same for the observer as for the eye observed; for the latter must always fix the center of the lens through which the observer looks at the image. It is also necessary to take care to place the square in such a way that its sides shall be parallel with the horizontal and vertical meridian of the cornea. If, on the contrary, we give the square a diagonal position, the image perceived will be neither a square nor a rectangle, but there will be observed a species of parallelogram with curved and diffuse sides. By this experiment, carefully carried out according to given rules, may be diagnosed the existence of corneal astigmatism. But the question is to find the value of such astigmatism in dioptrics.

Messrs. Javal & Schiötz's ophthalmometer consists of a spy-glass mounted on a tripod which may be made to move on a wooden support (Fig. 7) by means of a groove in which the posterior leg slides. The spy-glass contains two objectives (AB), between which is placed a doubly refracting prism, E. The objectives each have a focal distance of 27 centimeters. If the eye observed is placed at D (the focus of the objective, B), you will have at the point, C (the focus of the objective, A, at which is placed a thread from a cobweb), a reversed and same sized image of the images reflected on the cornea of such eye. To the tube of the spyglass (Fig. 7) there is fixed an arc of 36 centimeter radius whose center is a little beyond the focus, D, of the objective, B. This arc, which may be revolved around the axis of the instrument, is provided with a needle which indicates on a fixed graduated dial, E, the degree of rotation. You must begin your examination by focusing the apparatus.

Fig. 10.

The power of the doubly refracting prism is such that it exactly doubles an object of 3 millimeters situated at the point, D (Fig. 8.)

The question is to have an object whose image reflected from the cornea gives us at a single glance, in dioptrics, the difference between the refractive powers of the two principal meridians. We always speak of a cornea whose maximum convexity is in the vertical meridian.

Instead of using a simple square of white cardboard, Messrs. Javal and Schiötz have chosen two white bands, to one of which they have ingeniously given the form of a stairway, each of whose steps measures 6 millimeters. These bands serve as objects for the observed eye to aim at. They are fixed to the slides of the arc of the apparatus (M M', Fig. 7), and present themselves to the eye observed, as in Fig. 9, when the arc is in the vertical meridian of the maximum curve of the cornea. In our experiments, the object to be doubled is the corneal image of the space, D, included between the external edges, *a b*, *c d*, of the two white bands. We shall see further along how the position of the slides may be regulated so that the corneal image of the interval between the external edges of the two white bands shall be

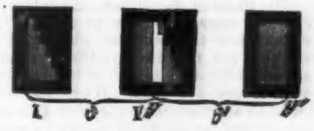


Fig. 11.

equal to 3 centimeters—a condition that is necessary in order that such interval be exactly doubled by the doubly refractive prism. Fig. 10 represents the corneal image of the two white bands exactly doubled by the prism, and such as the observer sees it in the focus of the ophthalmometer. In Fig. 10, δ is the corneal image of the interval, D, between the external edges of the two white sight-objects (Fig. 9). The slides are regulated in such a way as to obtain this image corresponding to an exact doubling. It will then be certain that the interval, δ, between the external edges of the corneal image of the two sight-objects is 3 millimeters, and that the apparatus is in condition for making the observation properly.

This being done, let us turn the arc of the apparatus 90°, in order to examine the horizontal meridian whose curvature is less than that of the vertical one. The slides not having changed their position, the corneal image of the system of sight-objects will be necessarily incompletely doubled by the doubly refracting prism. By means of the ophthalmometer, we obtain an image in which the bands, I' y' (Fig. 11), which, in the preceding experiment, exactly joined each other by their external edges, lap over one another by *two steps*. This lapping is clearly shown by a whitish coloration which detaches itself well from the gray tint of the other parts. It is easy to understand the cause of such overlapping; it is a result of the incomplete doubling of the corneal image.

Two convex mirrors of different curvature give virtual images of different sizes of the same object placed at the same distance; and the more convex the mirror is, the smaller will be the image reflected. If the vertical meridian of the cornea gives an image, δ (Fig. 10), of the distance, D (Fig. 9), equal to 3 millimeters, the horizontal meridian will necessarily give a much larger one. The distance, δ (Fig. 11), being greater than 3 millimeters, cannot be exactly doubled by the prism; and there will be, then, an overlapping of the images at the focus of the ophthalmometer. The bands, I' y, will be partially superposed.

We have said above that the steps cut out of one of the

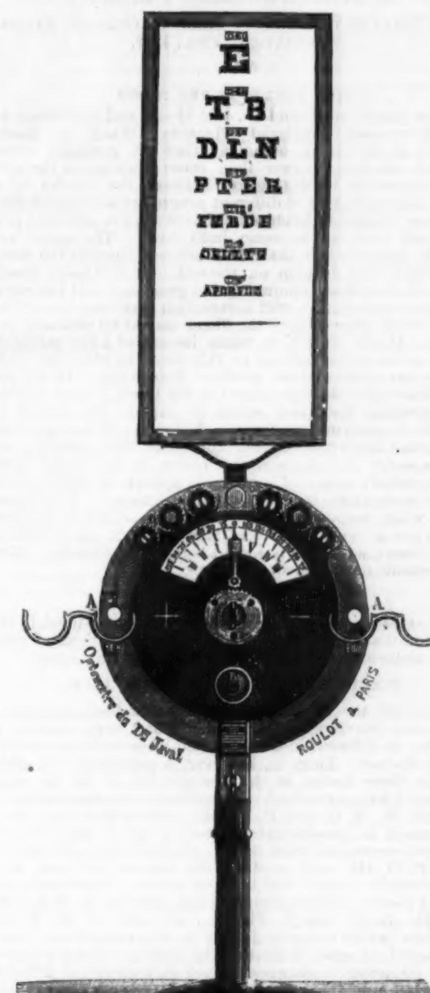


Fig. 12.

sight-objects were 6 millimeters in size; the apparatus is regulated in such a may that the overlapping of *one* step shall correspond to a difference in refractive power equal to *one* dioptric. Since we have admitted, in our experiment, an overlapping of *two* steps, we conclude therefrom that the power of refraction of the horizontal meridian is less, by *two* dioptrics, than that of the vertical. The astigmatism of the eye observed, then, is *two* dioptrics.

The direction of the principal meridians of the cornea is indicated by the position of the needle on the dial, E (Fig. 7). If we have to examine a person operated on for cataract, the value of the corneal astigmatism coincides with the total astigmatism, and the examination is finished. But in eyes not deprived of the crystalline lens, it remains for us to learn the astigmatism of the latter. Science has not as yet given an objective method of determining this; and we can only accomplish it in a roundabout way. We are forced to first seek the total astigmatism, and then, by a simple subtraction of the corneal astigmatism, to calculate that of the crystalline.

To examine the total astigmatism, we are obliged to abandon the exact objective method that permits physicians to make the examination independently of the more or less precise answers of the patient.

Thanks to Dr. Javal, we can also shorten such an examination and dispense with those test-glasses which require of the patient and physician much time and patience.

In his new *optometer* (Fig. 12), Dr. Javal has arranged on two revolving disks a series of convex and concave spherical glasses, and a series of cylindrical ones. By means of a peculiar mechanism the cylindrical glasses are made to move and place their axes in the desired direction. Such direction of the axis is indicated by a needle on a graduated scale.

You have only to put the needle on the angle already indicated by ophthalmometric observation, and to cause the cylindrical glass to pass that neutralizes the corneal astigmatism. By a rotation of the second disk we find the spherical glass a corrector of myopia or hypermetropia; and it is afterward but an affair of an instant to verify the fact as to whether the neighboring cylindrical glasses are preferable to the cylindrical glass indicated by ophthalmometric measurement.

This done, we subtract the value of the corneal astigmatism from the value of the total astigmatism. The result shows the intensity and direction of the crystalline astigmatism. This method requires much less time than it takes to explain it; and with its great rapidity there is joined the advantage of great accuracy. And we may add, too, that the management of the apparatus is easy for the physician and convenient for the patient.

Notwithstanding the long details that this explanation has required, I am happy to have had the occasion of presenting to you the latest progress made in modern ophthalmometry in France. I close with the hope that you are convinced of the scientific value of these methods, which you will certainly be able to employ to the advantage of your patients.—*Revue Scientifique.*

[Continued from SUPPLEMENT No. 382, page 6098.]

MALARIA.

By JAMES H. SALISBURY, A.M., M.D.

PRIZE ESSAY OF THE ALBANY MEDICAL COLLEGE ALUMNI ASSOCIATION, FEB., 1882.

VI.

AGUE PLANTS IN THE BLOOD.

AGUE plants are found in the blood and secretions of patients exposed to malarial influences. When the plants develop in the human organism, they are perfectly colorless and somewhat larger than those growing on the soil. It is impossible to distinguish between the species of a genus, but the spores of different genera are distinguishable. They are frequently found of different sizes in different persons, and even in the same individual. The spores are usually larger when the plants are developed in the body than when they develop on the soil. To find these plants in the blood and secretions requires great care and patience. No casual observation will accomplish any satisfactory result. Drop after drop of the blood should be patiently explored. Hours should be taken instead of a few minutes. When a case is worked up in this way, the physician feels that he has obtained some positive knowledge. In my observations upon the ague plants in the blood, I have noticed an interesting fact, that seems to explain the agency of quinine in intermittent fevers. It is this: Where patients have taken this agent largely for some time, keeping the system under its influence, the plants in the blood seem almost entirely empty of spores. It appears to destroy their power to organize the reproductive elements. This is precisely what might have been expected; as we well know that it has a remarkable tendency to check the growth of yeast plants, and is a powerful agent in preventing other cryptogamic development—N, Plate VIII.

SPUTA.

For evidence that the gemiasmas have been found in the expectoration and nasal discharges of ague patients, I refer to the histories related in the former part of this essay.

PLANTS IN THE PERSPIRATION OF AGUE.

These are the same that occur on ague bogs, and which have been previously described. They vary greatly in quantity in different individuals, and often with the severity of the disease. There is, however, a constancy and sameness in these bodies, in the perspiration of all the ague patients I have examined. These bodies are represented at L, L' M, M', N, O, and P, Pl. III. Sometimes they occur aggregated in considerable masses, as at O, with fungoid filaments vegetating from them. At others they are smaller, as at P, Pl. III., and at others the minute cells are scattered loosely, as at L and L', same plate. Occasionally the perfect plants in their simple form occur as at M and M', Pl. III. At N and S, Pl. III., are cells of the Torula cerevisiæ, which occur uniformly in the perspiration, urine, and blood of ague, indicating the presence of sugar undergoing fermentative changes. They vary greatly in different cases, but are always present, so far as my observations have gone, which have extended to over one hundred cases.

At Q, Q', and R, Pl. III., are represented the asci of a species of Puccinia, resembling that which attacks wheat, and produces so much injury to this grain. These were found abundantly in the perspiration of a baker who was laboring under ague. This is interesting; but whether they produce any derangement of the perspiratory apparatus, or of the system, I am unable to say. At Q' one of these asci has ruptured and is shedding its spores.

PATHOLOGY OF INTERMITTENT FEVER.

The lesions in intermittent fever are confined mostly to epithelial structures, showing quite conclusively that the exciting cause acts primarily upon the parent epithelial cells, or those cells that either organize the products that nourish the several tissues, or disorganize those of interstitial decay, so as to prepare them for ready elimination. These derangements consist in the altering and enlarging of glandular structures, and in inflammations and alterations in structure and function of the mucous, epidermic, and serous surfaces. All other abnormal manifestations are either symptomatic of these, or are the result of previous disease in the organism.

All the glands in the body belong strictly to epithelial tissue, and are made up mostly of parent epithelial cells. These structures are affected in time and extent apparently in proportion to their importance in organizing and assimilating products for nutrition, or disorganizing those for elimination. Of all the lesions met with in fatal cases, those of the spleen and liver—most important organs of the body—are the most frequent. The spleen increases in bulk and consistence; its structure is easily torn; its interior often being found to be broken down, and composed of a blackish red pulpy mass, with which are mingled fibrinous portions of a lighter color. Morgagni gives one case where the spleen weighed eight pounds; and another is mentioned by Bailly that weighed nearly ten pounds, the structure being entirely converted into a pulp. The spleen has been occasionally ruptured, and the broken down and altered tissue emptied into the abdominal cavity. This indicates an altered condition in the organizing processes of the parent epithelial cells of the organism, by which the fibrinous matters and other products of the blood formed become deposited in the splenic tissue, thus producing enlargement, so called "ague cake," which often, if the patient is not removed from constant accessions to the disease, and the exciting cause not eliminated from the organism, results sooner or later in disorganization and frequently in disintegration of the gland. The liver is also in some cases found greatly enlarged, and altered but little in structure. In others it is softened, or filled with black blood, or tuberculated, or containing purulent deposits.

The pancreas is also frequently hardened, so as almost to resemble scirrhus. The mucous membrane of the stomach, duodenum, and small intestines is likewise sometimes involved.

The mesenteric glands are frequently enlarged, and are subject to very nearly the same derangements in function and structure as the spleen. The exciting cause inhaled, taken into the system in the food and drinks, and absorbed by the skin and mucous surfaces comes into direct contact with the epithelial cells, spreading over and covering the entire body, both internally and externally, wherever there are any ways by which external bodies may enter the organism. The epithelial cells, hence, make up the first tissue of the system with which these poisonous bodies come in contact. These cells they have to pass through before they can enter the systemic circulation and reach the vascular tissues.

In passing through these cells, they derange them so as to poison the products they organize. In this way the masses of fibrin, and hence the ease with which the blood contents of the spleen may be washed out. Wherever the whole mass of the blood of the body becomes very abnormally thin, we may look to the spleen for the primary lesion.

Some of the interesting symptoms of intermittent fever, where the spleen is involved (Dr. Tweedie), are depression of spirits, torpor of mind, inactivity of body, with much muscular debility, deadly paleness, or a yellowish hue tending to black or green more than in ordinary hepatic disease. There is great liability to hemorrhage from various regions of the body, to dropsy, dysentery, and to ulcers of the legs. The spleen is liable to take on a morbid condition in continued fevers, as well as in intermittents. Diseases of the heart, stomach, and liver are liable to be accompanied by diseases of the spleen. The spleen is more liable to be affected with diseases in damp, wet, marshy localities than in other situations. In intermittent fevers there is a diminution of red globules and fibrin; softening and the breaking down of the spleen in intermittent and continued fevers, in scurvy, and in some varieties of malignant dysentery. By understanding the true functions of the spleen, these symptoms and lesions are all traceable to their true cause.

Depression of spirits and torpor of mind may arise from either oxaluric or phosphatic states, or from a defective supply of fibrin to muscular tissue; the yellowish hue, to a defective supply of red globules; the great liability to hemorrhage in different parts of the body, dropsy, and

PLATE VI.—A, Filamentous development of the acetous fermentation vegetation, a species of Penicillium. B, Vegetating spores of mature plants of same. C, Mature plants of same bearing fruit. D, Torula cells. E, Same as A—another species. F, Same as B. G, Torula cells. K, L, and M, Sphærotheca spores. N, Oxalate of lime. O, Empty amyloid cells. P, Epithelia. Q, R, S, T, Sphærotheca spores.

PLANTS THAT EXCITE FERMENTATION IN INTERMITTENT FEVER URINE.

other tissues, including the ganglionic and cerebro-spinal systems, become involved. As the epithelial cells of the glands, especially those of the spleen, mesentery, and liver, are the most largely engaged of any in organizing nutrient products for the other tissues, these glands are the most severely taxed, and are the first to suffer extensively from the poisonous palmellæ, and hence it is that in these we find so frequently grave lesions. When the tissues have become poisoned to a certain extent, there is a reaction on the part of the system, an effort of nature to eliminate the poisonous products already in the body. This effort is the paroxysm which constitutes what we call the disease.

We can readily see how it is that the blood of the body should become thin—deficient in fibrin—as soon as the functions of the spleen are partially or wholly suspended. This being the gland which organizes fibrin more largely than any other, if its function in this respect be suspended by the blocking up of the oval splenic bodies with partially organized fibrin, one great source of this product would be cut off from the blood. The fibrin already in the blood becomes deposited in the tissues, and one important source being cut off, the blood becomes thin and deficient in the body. This thin blood fills up all portions of the organ not occupied by dysentery, to an enervated condition of the heart, to thinness of the blood, and the defective supply to it of its normal products.

The probable reason why the spleen is so liable to take on a morbid condition in continued fevers as well as in intermittents, is that the exciting causes of both affect primarily the epithelial tissue, and have a tendency to derange those portions most which are the most actively engaged in organizing nutrient products, the reason of which appears to be that the exciting causes exist alike in the materials we eat, drink, inhale, and absorb through the skin.

The reason why the skin and spleen are more liable to be affected in damp, marshy localities than in other situations, is that in the former districts miasmatic poisons impregnate more or less the air, the water, and the food. The reason of the diminution of fibrin and red globules in the blood in intermittent fever is a greater or less suppression of the normal functions of the spleen and the mesenteric glands.

PLANTS THAT EXCITE FERMENTATION IN THE URINE OF AGUE.

In the urine of all cases of intermittent fever, the spores of penicillia are present, indicating the presence of glyco-

genous matter undergoing fermentative changes. These cells are generally more abundant in obstinate types, and in cases of long standing, than in the milder forms and recent cases. These observations apply equally well to the blood of this disease.

In several instances—in my observations—where the patients had been laboring under severe and obstinate forms of the disease, such as were exposed to constant accessions for many weeks, tending to typhoid conditions of the system, the urine was found containing numerous vegetating fungoid filaments, which were the developing mycelia of penicillia, aspergilli, or sphærothecæ. The filamentous growth of the same fungus produces, during the vinous fermentation in urine of ague, the so-called *torula cells*. In these obstinate cases of the disease, the urine passes rapidly to the acetous fermentation, even before it is voided, ushering in filamentous development in the cryptogams present, or the development of the mycelia of yeast plants. This fermentation progresses so rapidly that in a few hours after the urine is voided putrefactive fermentation begins, and small, white, cottony flocs or tufts of fertile threads appear above the surface. These soon bear fruit, when the plants are discovered to belong either to the genus Pencillium, or to the genus Aspergillus, or the genus Sphærotheca, and sometimes all.

The torula cells of the vinous fermentation in urine are exhibited in their early stages at D and G, Pl. VI., and at N, two different species of penicillium. That at E is the mycelium of the mature plant represented at C, Pl. VI. The mycelium, E, was beautifully developed in a boy (James Scott), aged 13, who resided immediately on the northwest margin of the "ague bog" on the southeast side of the city of Lancaster, Ohio. The whole family have been constant sufferers from ague every year since they moved to this point, from May till November. The water used comes from a spring at the edge of the bog.

This boy (James) had been laboring under ague (type quotidian) from the preceding May up to the time of this observation (Oct. 1), when this sample of urine was voided during the sweating stage; boy pale, emaciated, and puny, indisposed to mental or physical action.

In this sample of urine also occurred abundantly the spores of a species of Sphærotheca that grows upon the ague bogs, with the ague palmellæ. These are represented at Q, R, S, K, L, and M, Pl. VI. These occur more or less in the urine of most cases of ague, and often in that of health. There were also found in this sample of urine, crystals of oxalate of lime, which are seen at N, Pl. VI., O, Pl. VI., empty amyloid cells, P, Pl. VI., epithelial cells.

The mycelium, represented at A, Pl. VI., is from the urine of a young man aged 26, who resides immediately on the east margin of low, humid, rich ground, which is covered with ague plants. He was attacked with obstinate in-

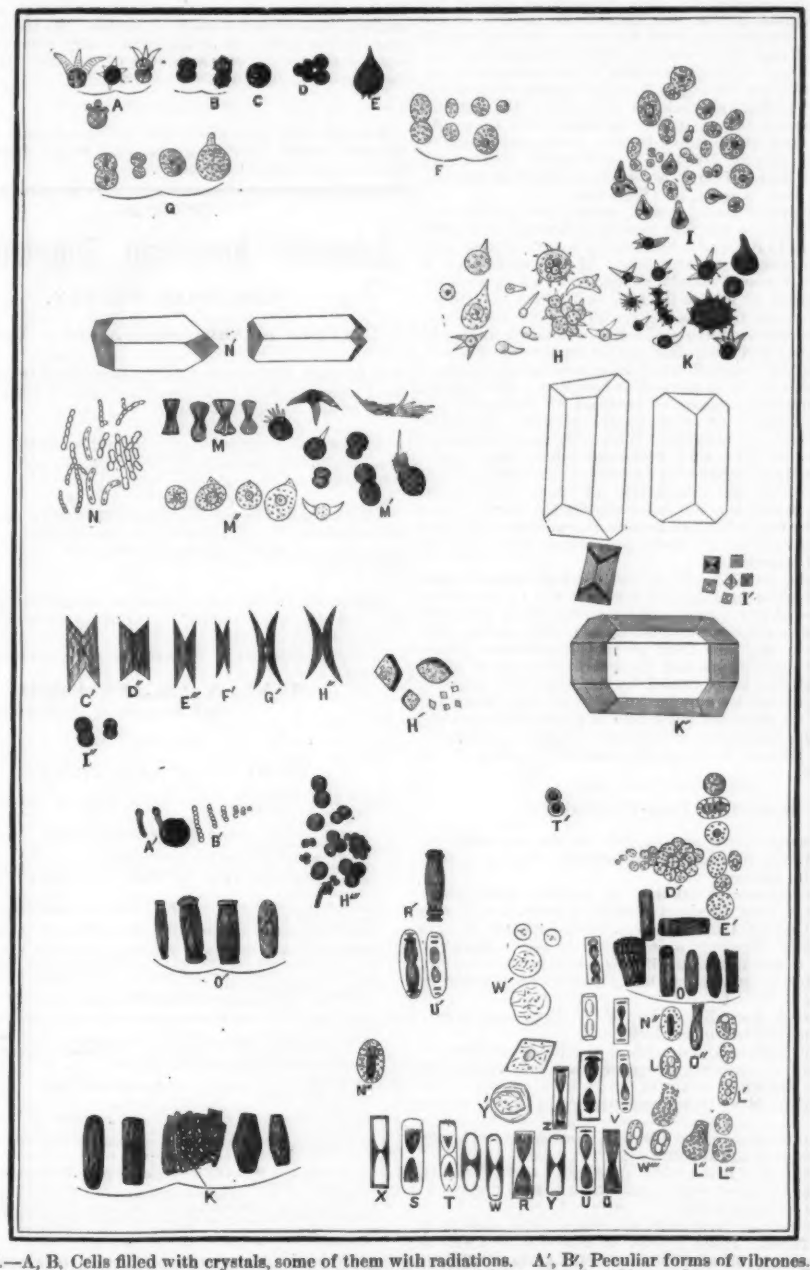


PLATE VII.—A, B, Cells filled with crystals, some of them with radiations. A′, B′, Peculiar forms of vibrones. C, Crystalline cell with no projections. C′, D″, E″, F′, G′, H″, Rhomboid forms of uric acid—rarely met with. D, E, Crystalline cells. D′, E′, Epithelia. F, Epithelia; contents dissolved out by nitric acid. G and H, Thin walled cells left after A, E, K, M, were treated with nitric acid. H′, Rhomboid forms of uric acid. H‴, Crystalline bodies with organic framework in concentric layers. I, Cells partially dissolved out by nitric acid. I′, Oxalate of lime. K near I, Crystalline cells with projections, save one to the right. K near X, should be P, Crystalline cells. K′, Triple phosphate crystals. L, L′, L″, L‴, N′, N″, and W‴, Cells in which this form of deposit has just begun. M, M′, Crystalline cells of uric acid. M″, Cells in more complete solution by nitric acid. N, Embryonal fungoid vegetation. N′, O′, Oxalate of lime according to Hassall and Golding Bird. O, O′, O″, Crystals deposited in cells. Q, R, S, T, U, U′, V, W, X, Y, Crystals in process of solution by nitric acid. W′, Light membranous cases left from the solution in nitric acid. Y′, Epithelium with crystalline plate inside. T′, Algæ. Z, Peculiar form of uric acid found in urine.

CRYSTALLINE FORMS FOUND IN THE URINE OF AGUE PATIENTS.

Pl. VII. The filamentous developments accompanying the acetous or acid fermentation are exhibited at A and E, Pl. VI. The mature plant, bearing fruit, is represented at C, Pl. VI. The vegetating spores of the mature plant are represented at B and F, Pl. VI. There is a beautiful species of penicillium often present, having symmetrical heads; the stem dividing first into four equal pedicels, which ascend close together a short distance, then abruptly diverge from each other, and soon subdivide, each into four pedicelets, each one of which bears a long moniliform line of spherical spores.

I do not know that this fungus is at all injurious of itself in the urine, but it indicates the presence of glycogenic matter, and rapid fermentative changes, which are abnormal.

The mycelia exhibited at A and E appear to belong to termittent fever in the early part of the season, which during the month of August gradually passed into typhoid conditions, from which he recovered about the 1st of September. On the 20th of September intermittent fever again set in. On the 28th this sample of urine was voided, during the sweating stage of a paroxysm. It had a deep reddish amber color, and in the bottom was a reddish brown sediment, made up of the echinated bodies, known as lithates of the alkalies, represented in Pl. VII., and which will soon be described. Scattered through the urine were flocs of the mycelium represented at E. In a few hours white cottony tufts of fertile threads began to appear on the surface. These soon bore fruit, when a beautiful species of penicillium was exhibited.

In another case this fungus appeared in the urine of a little girl aged two and a half years, after she had been laboring under the quotidian type of the disease for several weeks. This type gradually passed into remittent and then in a continued typhoid type or fever, which finally resulted fatally. Several other cases of this character have fallen under my observation during these inquiries. The above three will, however, suffice to give a general idea of the peculiar form of the disease which tends to this rapid fungoid development in the urine.

These growths are undoubtedly but the consequence of particular pathological states, and not the cause. Their presence is indicative of rapid fermentative changes in the system, and in this respect are valuable aids in diagnosis, and useful in directing our attention to such medicinal means as may counteract this abnormal fermentative condition.

THE FORMS OF CRYSTALLINE MATTER MOST USUALLY MET WITH IN THE URINE OF INTERMITTENT FEVER.

The crystalline sediments of intermittent fever are somewhat peculiar, and by no means as common as those of the urine of typhoid and other continued types of fever. The rhomboidal plates and prisms of lithic acid, so common to all typhoid types of disease, are seldom met with; and when they are, they are in small quantity and occur in those cases having a typhoid tendency.

What are known as lithates of the alkalies—lithates of soda, potassa, and ammonia—and the hour glass and octahedral crystals of oxalate of lime, and the hour glass type of crystals supposed to be one form of lithic acid are frequently met with in obstinate and continued and neglected cases of the disease. They are also found occasionally in what appear to be mild types of intermittents. Crystals of the triple phosphates are also accompaniments often of the more obstinate forms. The peculiar crystalline forms represented from O to Z, Pl. VII., are met with in some cases in great abundance. The crystals represented at O^1 and N^1 are regarded by Hassall and Golding Bird as belonging to the oxalate of lime group, while those represented at O, Q, R, Y, S, etc., are regarded by them as one form of lithic acid. There is, however, but little doubt that both of these varieties in form are the same type of crystal and are made up essentially of the same proximate body.

All these crystalline forms are represented in Pl. VII. The rhomboidal crystals of lithic acid represented at H^1 are seldom met with, save where there is a tendency to typhoid conditions. The same may be said of the forms exhibited at C′, D″, E″, F′, G′, and H″. The other forms represented, excluding the crystals of phosphates, and octahedra of oxalate of lime, are those to which we wish to direct special attention, from the fact that they are peculiar in form, not well understood, and from the interesting consideration that their form appears to be to some extent determined by an organizing process. These crystals are all deposited in developing cells. These cells are from the epithelial lining of the urinary organs. What are known as lithates of the alkalies are cells in which the filamentous metamorphosis has commenced, giving sharp prominences and spinous projections to the cell walls. At this stage acicular crystalline matter begins to be deposited in the cells, the crystals radiating from the center, and shooting into the cell prominences and spinous prolongations. When the cells become filled with crystalline matter, they appear yellowish and opaque, and have no longer any of the apparent characteristics of a cell. Cells filled with crystals in this condition are represented at A, E, K, and M′, Pl. VII.

If to these cell crystalline bodies placed between the slides of the microscope nitric acid be added, the crystalline matter is seen to be gradually dissolved out, with considerable effervescence, and we have, finally, the light, empty, thin walled cells left, with spinous projections and prominences in their walls, as seen at G and H, Pl. VII.; at I the cells are exhibited with the crystalline matter but partially dissolved out; and at M″ the solution is still more complete. Sometimes the cells, filled with crystals, have no sharp projections; one of these is represented at C, and another is seen in the group, K. When the crystalline matter is dissolved out of these, they present the appearance exhibited at F, Pl. VII. The peculiar crystalline forms represented at O′, R′, O, and O″, Pl. VII., are equally interesting, and appear also to be deposited in cells.

At L, L′, L″, N′, N″, and N‴ are seen cells in which this form of crystal deposits has just begun. These cells do not differ from the cells L‴ and E′, which are from the epithelial tissue lining the urinary organs. As these deposits progress, they assume successively the appearance exhibited at O, O′, R′.

If now the crystals, O′, R′, be placed between the slides of the microscope, and nitric acid added, the crystalline matter is gradually dissolved, with effervescence; and there finally remains a simple thin, light membranous casing, represented at W′, Y, Y′, Pl. VII. The successive appearances of these cells as the crystalline matter is gradually more and more dissolved, is represented at Q, R, S, and T of one kind, and at U, U′, and V for the other. When deprived of crystalline matter, nothing but a thin, highly transparent, cylindrical cell remains, with a faint hour glass marking internally, as represented at X, W, and Y. We here have then a type of crystallization going on in living, metamorphosing cells, from the epithelial tissue of the urinary organs, and bearing a not distant resemblance to diatoms. They appear to be connecting links between the lowest vegetable forms, the animal epithelial cell, and the mineral kingdom. These forms can no longer be regarded as simply mineral crystallizations. They are crystallizations brought about and controlled by organic life, and are under the direct influence of developing and metamorphosing cells. Here we perhaps may learn something connected with the formation and development of bony tissue.

In examinations connected with the minute structure and functions of the kidneys, I have arrived at data which satisfies me that the kidneys perform important functions connected with the formation of bony and cartilaginous products.* Every one is familiar with the remarkable tendency existing in the urinary apparatus to the formation and deposition of bony concretions, in the shape of gravel, calculi, etc. This matter is more fully treated in the paper above referred to.

At Y′ are epithelial cells with crystalline plates forming within.

At T′ are a couple of algoid cells. This species is seldom found in the urine. At A′ and B′ are represented two peculiar forms of the so-called vibriones. The form exhibited at A I have met with only in a couple of instances. One of them was in the urine of a married female patient laboring under obstinate phosphuria.

* For an extended view of this matter, see my paper on the minute structure and functions of the kidneys.

TREATMENT.

Since nature in the last stage of the paroxysm excites all the excretory organs of the body, and especially the perspiratory, urinary, and mucous surfaces generally, and as these excretions contain spores and plants of the ague palmellæ, it is evident that the sweating stage is a curative process. If so, it points us to important medicinal means as aids in eradicating the poison. These are diuretics, diaphoretics, expectorants, and alteratives. While we should keep quinia constantly in the front rank to impart tonicity to the ganglionic and cerebro-spinal systems and to the epithelial tissue, and to control in the body cryptogamic development, we should use diaphoretics, diuretics, and expectorants freely as eliminators. The nightly sweating of the patient laboring under the disease might be supposed to result in enervating the system. The reverse, however, is the case. Under active nightly diuresis and diaphoresis, in ague, the sallow countenance rapidly clears up, the dull eye becomes bright, the depression of spirits and torpor of mind and body disappear, and give place to the elastic step and tonicity of muscle. The result is that even when the system is exposed to constant accession the paroxysms are not only avoided, but organic lesions and the long train of unpleasant symptoms are not allowed to get their hold upon the system, the ague poison being eliminated as fast as it is taken into the organism.

In cases where the patient is removed from the exciting cause, the system is soon thoroughly cleansed, and no ague returns the following spring unless there are new exposures. The power of the system to resist paroxysms of ague varies greatly in different individuals, and even in the same individual at different periods. This power of resistance is directly proportioned to the tonicity of the system. Habits of bracing, active exercise, such as horse-back riding, will often protect the system against attacks. This is noticed in a marked degree in the cavalry and infantry service of the army. In malarious localities, the former are seldom attacked, if on active duty, with intermittent fever, while the latter are extremely liable to suffer. This is the case when both branches of the service are occupying the same malarious district, and are equally exposed. Quinia as a prophylactic enables the system to resist the paroxysms. It braces up the system and controls cryptogamic growth till nature can effect a cure by eliminating the malarious cause through the skin, mucous surfaces, and kidneys. Quinia then is not, strictly speaking, a curative or specific agent, but simply acts beneficially by controlling cryptogamic development, and imparting such tonicity to the organism as enables it to resist the paroxysm till aided nature can cure the disease by eliminating the cause. Any cause that enervates the system in malarious regions tends to bring on the paroxysms earlier than they otherwise would appear. Very frequently it is noticed, especially when the system has been under the influence of the disease for some time, and most especially if the disease is contracted in a region where there is a tendency to congestive paroxysms (limestone regions especially), as in the southern part of Tennessee, in Mississippi, and Louisiana, quinia appears at first to have some influence in enabling the system to resist the paroxysms, but soon loses almost entirely its power. In fact, in many instances it really aggravates the paroxysms, as is evidenced by stopping the quinia entirely. In such cases the skin will be found dry, the mucous surfaces less active than normal and covered with a scant, clammy, mucous secretion, and the renal secretions small; in fact, all the eliminating organs have their functions deranged and their normal action partially suppressed. As long as these are in this condition, the malarial poison is hemmed up in the organism, so much poisoning the tissues that the tonic influence of the quinia rather tends to aid frequently the abnormal actions than to restore the normal tone.

If, however, the normal functions of the eliminating organs are restored and the spleen and liver properly attended to, quinia will again act beneficially and soon eradicate the disease, especially if the patient be removed from constant accessions. It is highly important to keep the eliminating organs in a healthy and rather increased state of action when the system is under the influence of any malarious poison, as it is through these channels that the causes are eliminated. We have then in this disease no such thing as a specific in quinia. It simply imparts tonicity to the system and controls cryptogamic development till nature, aided by remedial means for exciting the excretions, is able to eliminate the poison. These principles should be strongly impressed upon the mind of the physician who has charge of malarious diseases. Many old and obstinate cases of ague, with the system filled with the malarious poison, and all the channels of egress closed, are being daily dosed largely with quinia, arsenic, and iron, with little or no effect, with the view of curing the disease in some empirical and mysterious way by these so-called specifics. The very name specific should be blotted from medical science, and left entirely to the quack, who knows nothing else. There is really no such thing in medicine. All we can do in any disease is to aid nature, and to follow her as closely as possible in her curative processes and this we can only do wisely and well by understanding fully the true cause and pathology of every disease we treat.

In treating intermittent fever, it is of the first importance to correct any abnormal condition of the portal system, and to accompany this by diuretic, diaphoretic, and expectorant remedies, to excite into activity all the eliminating organs of the body. It is impossible to mark out a fixed course for all cases. The following prescriptions will, however, illustrate the general plan of treatment:

R.	Potass. acetat........................	℥ii ʒi.
	Spts. nitr. dulcis........................	℥i ʒiv.
	Syr. scill. comp........................	℥ss ʒiss.
	Aquæ menth. pip........................	℥viii.

M. S. Take from one to two tablespoonfuls in a glass of water, morning, noon, and night. Every evening, on retiring, take a warm diaphoretic draught. Also—

R.	Quinia sulph........................	Gr. xxx.
	Strychnia sulph........................	" ¼.
	Mass hydr........................	" iv.
	Pulvis capsici........................	" xx.
	Ferri lactat........................	" xx.
	Ext. gentian,	
	Syrup........................	āā q. s.
	Make pills xxx. S.	

Take two pills every two hours till thirty-two are taken. Every day or every other day after, according to the type of the disease, take four pills two hours before the time for the paroxysm. At the end of ten days, take two pills every two hours till thirty-two pills are taken, and continue as before for ten days more, then take thirty-two more pills. By this time, if the eliminating remedies are kept faithfully up, the patient will be thoroughly cured if he is not exposed to constant accessions. If he is, the eliminating organs must be kept constantly excited, that the cause may be removed as fast as it enters. Under this treatment a paroxysm need never occur after the commencement of the remedies. The means are within our reach for removing the prolific cause of intermittents. Rich, humid, low grounds, which produce ague plants abundantly when they are new, undergo some changes by culture and drainage that unfit them for the growth of the palmellæ.

As the malarious portions of the country become older, and the low, humid, rich grounds become drained and cultivated, ague districts will become more and more circumscribed and intermittents proportionally decrease; as long, however, as there remain in such localities pools, ponds, ditches, streams, the beds of which are liable to become more or less dry during the warm summer months, intermittents may be expected to a certain extent to prevail. These sources of the disease, however, may be much lessened by turning the open ditches into blind ones, draining pools, swamps, and ponds, and subjecting the soil of their beds to repeated cultivation. By this process intermittents, which now extensively prevail over a large portion of our richest districts, may be so circumscribed in their limits as to be no longer a dreaded accompaniment to the most fertile agricultural sections of our country.

Where it is necessary to make excavations during the warm, dry months, in new, rich, humid soil, the bottom and sides of these excavations, with the earth removed, should at the close of each day's work be plentifully sprinkled over with caustic lime. If this precaution be well attended to, the ague plants will not develop. It is also highly desirable in making ditches through malarial soil to keep the bottom, sides, and thrown up earth well sprinkled with lime. As fast as the beds of streams, ditches, pools, and ponds in ague districts become dry, they should also be well strewn with caustic lime. This is especially desirable in this climate during July, August, and September.

When new prairie lands, or new, humid, low grounds are being turned up for the first time, and lime can be readily obtained, it will save much sickness by sowing it over with a good top dressing of caustic lime. If one application is not sufficient, a second should be made. This application will by no means be lost on the soil, as it serves to neutralize acidity, convert resinous matters into soluble soaps; and the soil is thereby rendered more fertile, and its increased and better crops will more than pay for the lime application. If lime cannot be obtained, wood ashes may be used, though their effect will not be as marked or enduring. In selecting camping grounds for armies, or locations for hospitals, new soil and low prairie or other humid grounds should be avoided as much as possible. Wherever open ditches are made, streets are excavated, wells and cellars dug, or new earth thrown up or exposed in any way to the drying influence of the sun and atmosphere of May, June, July, August, and September, and especially during the two latter months, if the region is at all malarious, caustic lime should be freely strewn over all such excavations, and over the heaps of soil removed.

To conclude, if the health of the residents is in splendid order, the eliminating glands of the body will throw off the poison as fast as introduced. But this should be reckoned among the labors of the constitution, and such exposed individuals should not task their powers in addition. I here also say that I only claim that the intermittent fever that I have studied has been caused by the plants in question. Ague in other localities may be caused by the same and other vegetations. A wide and open field is presented which demands of the profession occupation. Studies should be made of the Panama fever, as they have been made of the Roman fever.

REMEDIES FOR HEADACHE.

THE following recipes and suggestions for the treatment of different forms of headache are collected from a variety of trustworthy sources:

Two grains citrate of caffeine, in capsule, taken every half hour, is a very effectual remedy in nervous and sick headache. One or two doses are often sufficient to give complete relief. The only objection to its use is sleeplessness, which sometimes results if it is taken in the evening. It is preferable to guarana as being hardly ever rejected by the stomach.

The following, according to Dr. W. W. Carpenter, is very effectual in most forms of headache:

Muriate of ammonia, 3 drachms; acetate of morphia, 1 grain; citrate of caffeine, 30 grains; aromatic spirits of ammonia, 1 drachm; elixir of guarana, 4 ounces; rose water, 4 ounces. Mix. Dessertspoonful every ten or twelve minutes.

In nervous headache, Dr. W. A. Hammond states the value of various drugs as follows:

Oxide of zinc is of great value. Ordinary dose, 2 grains, three times a day, after meals; maximum dose, 5 grains. It is best given in form of pills.

Nux vomica is preferable to strychnia. The dose is ¼ grain, after meals. If the patient be chlorotic, it is well to combine a grain of reduced iron and half a grain of sulphate of quinine.

Bismuth, in the form of subcarbonate, will often take the place of oxide of zinc. Dose, 2 grains, after each meal. Bismuth probably aids digestion more than any mineral tonic, and is of use when there is gastric disturbance.

The bromines are serviceable when the nervous system has been irritated; when it is exhausted, they do harm.

Phosphorus is very useful in most forms of nervous headache. The best results are obtained from dilute phosphoric acid, in doses of 30 drops, largely diluted, three times a day, after eating, or phosphide of zinc, 0·10 grain, in pill, three times a day.

Arsenic as a nerve tonic, stands next in value to zinc. Dose, 5 drops of Fowler's solution three times a day, after meals.

Galvanism is sometimes valuable, but by no means a specific. The constant current should always be used, being careful to avoid too great intensity, lest amaurosis be produced.

Dr. T. Lauder Brunton, editor of the London *Practitioner*, says: "The administration of a brisk purgative, or small doses of Epsom salts, three times a day, is a most effectual remedy for frontal headache when associated with constipation; but if the bowels be regular, the morbid processes on which it depends seem to be checked, and the headache removed even more effectually by nitro-muriatic acid diluted 10 drops in a wine glass of water, or bicarb. soda, 10 grains, in water, before meals. If the headache be immediately above the eyebrows, the acid is best; but if it be a little higher up, just where the hair begins, the soda appears to be the most effectual. At the same time the headache is removed, the feeling of sleepiness and weariness, which frequently leads the patients to complain that they rise up more tired than they lie down, generally disappears."

A writer to the London *Lancet* remarks: "At the Middlesex Hospital female patients who have suffered many years from sick headache, evidently of a hereditary character, have been greatly benefited, if not cured, by the administration of 10 minim doses of tincture of Indian hemp, three times daily before the attacks. This is well worthy of trial in those cases of ever-living never-dying martyrdom-like suffering."—*Hospital Gazette.*

NEW COLORING MATTER.

ARCHIL substitute is the name given to this new dyestuff by the manufacturers, the well-known French firm of the Societe des Matieres Colorantes, formerly the famous firm of Poirrier. It is put on the market in the form of paste, and is employed on wool and silk in an acid bath (by means of sulphuric acid and sulphate of soda). The shades obtained differ very little from those obtained by means of archil, but are slightly yellower. With equal prices the substitute is said to be richer in color than archil, and also faster. It is, in fact, one of the fastest of the dyes derived from coal-tar. Like archil, it can be used in combination with other dyestuffs to give a great variety of shades. As the above firm manufacture archil, or archil extract, very extensively, it is some guarantee of the usefulness of the new dyestuff the they have undertaken its manufacture.

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